

FORM PCT 1390
REV. 5/93

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NO.
STICHT 36 PCTTRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)

09/485947

INTERNATIONAL APPLICATION NO.
PCT/AT98/00194INTERNATIONAL FILING DATE
AUGUST 18, 1998PRIORITY DATE CLAIMED
AUGUST 18, 1997

TITLE OF INVENTION

SMART AXES AND RELATED METHOD

APPLICANT(S) FOR DO/EO/US
WALTER STICHT

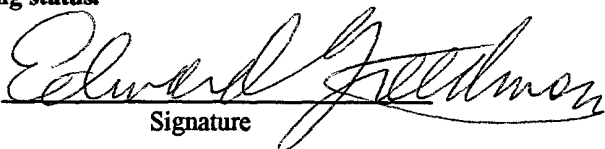
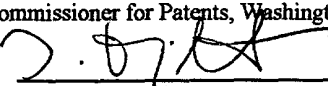
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371 (f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau)
 - b. ☐ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has **NOT** expired.
 - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A **FIRST** preliminary amendment.
☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:

PCT/ISA/210 - Int'l. Search Report (English)
Ten sheets of formal drawings

APPLICATION NO. (if known, see 37 CFR 1.5)				INTERNATIONAL APPLICATION NO. PCT/AT98/00194	ATTORNEY'S DOCKET NO. STICHT 36 PCT
09/485947 The following fees are submitted: Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO.....\$840.00 International preliminary examination fee paid to USPTO (37 CFR 1.482)\$670.00 Neither international preliminary examination fee paid (37 CFR 1.82) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO.....\$970.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4).....\$96 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS	PTO USE ONLY
				\$ 840.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than ____ 20 ____ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).					
Claims	Number Filed	Number Extra	Rate		
Total Claims	43 - 20 =	- 23 -	X \$18.00	\$ 414.00	
Independent Claims	1 - 3 =	- 0 -	X \$78.00	\$	
Multiple dependent claim(s) (if applicable)			+ \$260.00	\$	
TOTAL OF ABOVE CALCULATIONS =				\$ 1254.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				\$	
SUBTOTAL =				\$	
Processing fee of \$130.00 for furnishing the English translation later than ____ 20 ____ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$ 1254.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				See cover sheet attached to assign \$ to be charged to Deposit Acct	
TOTAL FEES ENCLOSED =				\$ 1254.00	
				Amount to be: refunded	\$
				charged	\$
<input checked="" type="checkbox"/> A check in the amount of \$ 1254.00 to cover the above fees is enclosed. <input type="checkbox"/> Please charge my Deposit Account No. 03-2468 in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment, to Deposit Account No. 03-2468. A duplicate copy of this sheet is enclosed.					
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO: COLLARD & ROE, P.C. 1077 Northern Boulevard Roslyn, New York 11576-1696 (516) 365-9802			 Signature <u>Edward R. Freedman</u> <u>Reg. No. 26,048</u>		
Express Mail No. <u>EL 416 540 812 US</u> Date of Deposit <u>February 17, 2000</u>					
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10, on the date indicated above, and is addressed to the Asst. Commissioner for Patents, Washington, D.C. 20231					
 Ingrid Mittendorf					

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT OR PATENTEE: Walter Sticht
SERIAL OR PATENT NO.: Int. Appl. No.: PCT/AT 98/00194
FILED OR ISSUED: 18th August 1998
GROUP: Ser. No. 09/485,947
TITLE: Smart axes and related method

COPY

SMALL ENTITY DECLARATION

☒ FOR INDEPENDENT INVENTOR(S)

As a below-named inventor, I hereby declare that I am an independent inventor who (1) has not assigned, granted, conveyed, or licensed, and (2) is under no obligation under contract or law, to assign, grant, convey, or license, any rights in the invention, to any person who could not likewise be classified as an independent inventor if that person had made the invention, or to any concern which would not qualify as a small business concern or a nonprofit organization, as defined in 37 CFR 1.9(c).

☐ FOR SMALL BUSINESS CONCERN

I hereby declare that _____ is a business concern which qualifies as a small business concern as defined in §1.9(d) - namely, (1) whose number of employees, including those of its affiliates, does not exceed 500 persons; and (2) which has not assigned, granted, conveyed, or licensed, and is under no obligation under contract or law to assign, grant, convey, or license, any rights in the invention to any person who could not be classified as an independent inventor if that person had made the invention, or to any concern which would not qualify as a small business concern or a nonprofit organization under this section; and that the exclusive rights to the invention have been conveyed to and remain with the above-identified small business concern.

I further declare that all statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful, false statements and the like, so made, are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful, false statements may jeopardize the validity of the patent application or any patent issuing thereon.

Each of the undersigned hereby grants the firm of COLLARD & ROE, P.C., 1077 Northern Boulevard, Roslyn, N.Y. 11576, USA, the power to insert in this Small Entity Declaration any further identification which may be necessary or desirable to comply with the rules of the U.S. Patent and Trademark Office for filing and acceptance of this Declaration.

INVENTOR(S)

Name: Walter Sticht
Date: 15th March, 2000

Name:

Date:

Name:

Date:

SMALL BUSINESS CONCERN:

By _____

Name: _____

Title: _____

Date: _____

PATENTIN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: WALTER STICHT (36)
SERIAL NO.: 09/485,947
PCT NO.: PCT/AT98/00194 PCT FILED: AUGUST 18, 1998
PRIORITY: AUSTRIAN NO. A1384/97 FILED: AUGUST 18, 1997
TITLE: SMART AXES AND RELATED METHOD

PRELIMINARY AMENDMENT

BOX PCT
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Preliminary to examination, please amend this application as follows:--

IN THE SPECIFICATION:

Page 1, cancel lines 1 and 2, and insert instead: --

The invention relates to a system comprising one or more displacement units and related method, as described in the preambles of claims 44 and 82.

EP 0 240 965 shows a compact electrohydraulic switching module which is used, for example, for driving displacement units which comprises a valve piston and a valve housing surrounding the valve piston with a drive arrangement formed by a coil, whereby the drive arrangement is driven by a command processing element, for example a microprocessor. --

Same page, after line 3, insert --

In EP 0 275 992, a method for driving a machine system, for example production lines, conveyor systems etc, with several actuators, especially electric motors but also other electrically controllable and electromechanical actuating devices are described, whereby some of the actuators are combined into a group and a control unit is assigned to each of the actuators in this group.

Similarly, a decentralized drive, for example of a displacement unit, is also described in FR 2 657 807.--

Page 2, line 2, change "1" to --44--;

line 7, after "necessary.", insert --In addition, accessibility to the individual components in the region of a machine is considerably improved if the two supply lines leading from the switching module to the drive unit are omitted by integrating the switching module into the drive unit or the components. A further advantage is the short lines which prevents undesired damping caused by the elastic stretching of the feed lines, friction losses etc., resulting in a considerable improvement in switching times, reaction times etc.

The objective is also achieved independently by the features described in the characterizing part of claim 45. In addition to the advantages described for claim 44, a surprising advantage over and above the overall effect can be achieved in that the short switching times and ways of optimizing the overall displacement sequence can be combined with the thereby achievable greater availability. --

line 8, change "2" to --46;
line 10, change "3" to --47--;
line 12, change "4" to --48--;
line 14, change "5" to --49--;
line 16, change "6" to --50--;
line 18, change "7" to --51--;
line 20, change "8 and 9" to --52 and 53--;
line 22, change "10" to --54--.

Page 3, line 1, change "11" to --55--;
line 3, change "12 to 15" to --56 to 59--;
line 6, change "16" to --60--;
line 9, change "17" to --61--;
cancel lines 12 and 13;
line 14, change "19" to --62--;
line 17, change "20" to --63--;
line 19, change "21" to --64--;
line 22, change "22" to --65--.

Page 4, line 1, change "23 and 24" to --66 and 67--;
line 4, change "25 to 27" to --68 to 70--;
line 6, change "28" to --71--;
line 8, change "29" to --72--;
line 10, change "30 and 31" to --73 and 74--;
line 13, change "32" to --75--;
line 16, change "33" to --76--;
line 18, change "34" to --77--;

line 21, change "35" to --78--.

Page 5, line 1, change "36" to --79--;

line 4, change "37" to --80--;

line 7, change "38" to --81--;

line 11, change "39" to --82--;

line 13, after "reference value" insert --taking into
consideration different target values for the respective use.--;

line 17, change "40" to --83--;

line 22, change "41" to --84--.

Page 6, line 1, change "42" to --85--;

line 3, change "43" to --86--.

IN THE CLAIMS:

Cancel claims 1 to 43, the original claims, and substitute
therefore new claims 44 to 86, attached hereto.

R E M A R K S

By this Preliminary Amendment, newly found prior art has been
incorporated into the specification and original claims 1 to 43 have
been replaced by new claims 44 to 86. These amendments correspond to
amendments in the International Application, and no new matter has
been introduced. In addition, reference to the canceled claims in

the specification has been amended to reflect the proper claim number. Entry of this amendment is respectfully requested.

Respectfully submitted,

WALTER STICHT



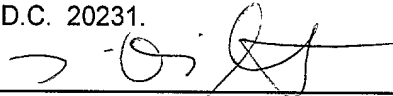
Allison C. Collard, Reg. No. 22,532
Edward R. Freedman, Reg. No. 26,048
Attorneys for Applicant

COLLARD & ROE, P.C.
1077 Northern Boulevard
Roslyn, New York 11576
(516) 365-9802
ERF:im/llv
Encls.: New set of claims

R:\INGRID\KELMAN\Sticht 36 Prelim. amend.wpd

EXPRESS MAIL NO. EL 416 542 115 US
Date of Deposit: April 21, 2000

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10, on the date indicated above, and is addressed to the Box PCT, Assistant Commissioner for Patents, Washington, D.C. 20231.



Ingrid Mittendorf

Claims

44. System comprising one or more displacement units, for example for supply, manipulation, joining or control systems of mounting parts with components (3; 4) that can be adjusted relative to one another by means of a drive unit (5) controllable by at least one switching module (10), in particular a pneumatic valve (11), and with at least one guiding device (6) for at least one of the components (3; 4) and a control unit (7), characterised in that at least one member (8) of the control unit (7) used for processing logic information or bus information (command) and the switching module (10) is integrated into the drive unit (5) and/or into at least one of the components (3; 4) and/or is mounted on one of the components (3; 4).

45. System comprising one or more displacement units, for example for manipulation systems for mounting parts with components (3; 4) that can be adjusted relative to one another by means of a drive unit (5) controllable by at least one switching module (10), in particular a pneumatic valve (11), and with at least one guiding device (6) for at least one of the components (3; 4) and a control unit (7) and/or a central control unit for providing reference values for a parameter of the displacement units (1), characterised in that at least one member (8) of the control unit (7) processing logic information or bus information (command) and/or reference and actual values of sensors is designed for comparing and adjusting the reference and/or actual values, and the control unit (7) and/or the control unit has a learning mode for bringing together the actual values to the reference values for determining target values and the member (8) of the control unit (7) and the switching module (10) are integrated into the drive unit (5) and/or into at least one of the components (3; 4) and/or is mounted on one of the components (3; 4).

46. System according to claim 44, characterised in that the control unit (7) comprises at least one control module (9) and/or one or more switching modules (10) assigned to the control module (9).

47. System according to claim 44, characterised in that the control unit (7), in particular the control module (9) and/or the switching modules (10), comprises inputs (52), for example for signals and/or commands of a central control unit (134) and/or the switching module (10) and/or the signalling and/or monitoring members (16) and/or control

units (7) of further displacement units (1) and/or external input and/or output devices (79) and/or drive units (5) and/or power.

48. System according to claim 44, characterised in that the inputs (52) are connected by single point plugs with single lines and/or by at least one multipoint plug (81) with at least one multipoint line and/or are connected by a bus connector plug (53) to a bus line (97) designed as a central connection line (179).

49. System according to claim 44, characterised in that the control unit (7), in particular the control module (9) and/or the switching modules (10), comprises outputs (54), for example for signals and/or commands to the central control unit (134) and/or to the switching modules (10) and/or to the signalling and/or monitoring members (16) and/or to control units (7) of additional displacement units (1) and/or to external input and/or output devices (79) and/or to drive units (5) and/or for power.

50. System according to claim 44, characterised in that the outputs (54) are connected by single point plugs to single lines and/or via one or an additional multipoint plug (81) to one or an additional multipoint line and/or via one or an additional bus connector plug (53) to one or an additional central connection line (179).

51. System according to claim 44, characterised in that the control unit (7), in particular the control module (9) has a memory (131) for storing, in particular individual movements.

52. System according to claim 44, characterised in that the control unit (7), in particular the control module (9), has a logic unit comprising at least one logic element (139), which forms the member (8), which processes logic information and/or commands and/or bus information, for example for determining and/or monitoring the positions of the components (3; 4) and/or the displacement parameters of the drive unit (5).

53. System according to claim 44, characterised in that the logic element (139) of the control unit (7), in particular the control module (9) is designed as a micro-processor (127) which is connected by conductors (128) or flexible control lines (49) with for

example an interface (129) for the bus connector plug (53) and/or an evaluation unit (130) and/or a memory (131) and/or an external interface (129) and/or a driver (132) and/or a D/A converter (133).

54. System according to claim 44, characterised in that the control unit (7) has a control power source, in particular a battery, an accumulator and/or an interface for an external power source.

55. System according to claim 44, characterised in that at least one logic element (139) is designed as an electronic module, for example a microprocessor (127) or a PC or SPS.

56. System according to claim 44, characterised in that at least one switching module (10) and/or one logic element (139) is designed for example as a pneumatic valve (11) and/or relay and/or contactor.

57. System according to claim 44, characterised in that the control unit (7), in particular the switching module (10) is connected to at least one drive unit (5) designed for example as a pneumatic drive (12), hydraulic drive, servomotor drive, electric motor drive, manual drive or piezo drive.

58. System according to claim 44, characterised in that the drive unit (5) has one or more transmitting elements which are connected to at least one component (3;4) and which are in the form for example of couplings, toothed belts, racks, spindles, gears or links.

59. System according to claim 44, characterised in that component (4) is arranged to move relatively on a preferably frame-shaped, other component (3) by means of a guiding device (6) designed as a linear guide (119) and/or rotary and/or gear guide.

60. System according to claim 44, characterised in that at least one component (3; 4) comprises one or more standardised interfaces (95) for control lines (49)

and/or lines (50) of further assembly and/or processing devices and/or additional displacement units (1) and/or for power and/or of control units (7).

61. System according to claim 44, characterised in that in the region of the interfaces (95, 101, 129) inputs (52) and/or outputs (54) of the control unit (7) are arranged, which are line-connected by plug connectors, in particular coupling devices with at least one control unit (7) of an additional displacement unit (1).

62. System according to claim 44, characterised in that the switching modules (10) are designed as valve cartridges (115), which are arranged in a guiding device (103) of the drive unit (5).

63. System according to claim 44, characterised in that the switching module (10), in particular the valve cartridge (115), comprises a control module (9).

64. System according to claim 44, characterised in that the pneumatic drive (12) designed as a pneumatic cylinder (13) has end face closing elements (14), which are positioned so as to be adjustable relative to one another on or in a cylindrical pipe (15) of the pneumatic cylinder (13).

65. System according to claim 44, characterised in that the signalling and/or monitoring members (16), are for example limit switches and/or proximity switches (17) and/or displacement measuring systems and/or position detecting systems and/or vibration sensors and/or force sensors.

66. System according to claim 44, characterised in that the component (3; 4) is secured by a securing device (122) arranged detachably on the other component (4; 3) in at least one direction of movement.

67. System according to claim 44, characterised in that the securing device (122) is formed for example by a damping device (123), a braking device or an arresting device.

68. System according to claim 44, characterised in that the control unit (7) comprises at least one display element (75), which is designed for example as a display (76) with text, number display, light-emitting diodes or as an acoustic information element.

69. System according to claim 44, characterised in that the control unit (7) comprises an input device (77), for example in the form of a keyboard (78) or a touch screen.

70. System according to claim 44, characterised in that the touch screen combines the display element (75) with the input device (77).

71. System according to claim 44, characterised in that the interfaces (95, 101, 129) and/or the inputs (52) and/or the outputs (54) are designed as plug-in coupling devices.

72. System according to claim 44, characterised in that at least one component (3;4) comprises an electric distribution bus bar (72) and/or a pneumatic distribution bar (55).

73. System according to claim 44, characterised in that the electric distribution bus bar (72) and/or the pneumatic distribution bar (55) comprises control lines (49) and/or lines (50) and/or channels (61), which are preferably integrated into the component (3;4).

74. System according to claim 44, characterised in that the switching modules (10) are arranged on and/or in the pneumatic distribution bar (55), which are preferably plug connected by openings (63) to openings (60) arranged in the pneumatic distribution bar (55).

75. System according to claim 44, characterised in that one component (3;4) comprises at least one securing device (118) for the signalling and/or monitoring members (16), preferably in the form of a guiding device (103).

76. System according to claim 44, characterised in that the signalling and/or monitoring members (16) and/or the switching modules (10) and/or the control modules (9) are arranged displaceably on the electric distribution bus bars (72), in the form of a bus line (97) for example.

77. System according to claim 44, characterised in that the signalling and/or monitoring members (16) comprise control modules (9) and/or logic elements (139).

78. System according to claim 44, characterised in that the input and/or output device (79), is designed for example as a keyboard and/or as a reading device for chip cards, magnetic cards, CDs, diskettes, tapes and/or as a data glove and/or a touch screen.

79. System according to claim 44, characterised in that the data is transmitted from the control unit (7) to the control unit (134) and/or from the individual components of the control unit (7) to the latter wirelessly, for example optically by means of lasers or for example by means of infrared or ultrasound.

80. System according to claim 44, characterised in that the position of the components (3;4) and/or the mounting parts (2) is detected by means of a local positioning system.

81. System according to claim 44, characterised in that the data glove is connected preferably couplably via inputs (52) and/or outputs (54) to the control unit (7) and/or the control unit (134).

82. Method for operating a displacement unit (1) and/or a system composed of several displacement units (1), in particular an assembly system in which reference values for the displacement unit, such as for example the displacement in x and y direction, speed, cycle time, feed force etc. are predefined in a control unit (7), in particular a control module (9) of the displacement unit (1) or in a central control unit (134), after which the actual values of the parameters of the displacement unit (1) or of switching modules (10) are detected and changed to said reference values, characterised in that by means of a learning mode provided in the control unit (7) and/or in the central control unit (134) at least one actual value of a

parameter of the displacement unit (1) is compared with at least one reference value for the parameter, adjusted to said reference value, or this value is defined as a reference value, which represents a target value optimised for example with respect to cycle time, wear, vibration etc., to which the actual values are adjusted to the parameters of other displacement units (1).

83. Method according to claim 82, characterised in that for each displacement unit (1) a learning mode is executed in which the actual value of a prespecified target value is determined, whereupon after completing the learning mode of the last displacement unit (1) said actual values are compared and are selected as a target value.

84. Method according to claim 82, characterised in that the target value is formed for example from the value of the greatest clock time of a displacement unit (1) or by the cycle time.

85. Method according to claim 82, characterised in that the learning mode is formed by fuzzy logic, neuronal networks or genetic algorithms in the control unit (7), in particular in the control module (9).

86. Method according to claim 82, characterised in that after the learning mode has been completed or during the latter a monitoring mode commences, which determines the interval between two consecutive activations of the learning mode, stores it and compares it with other such intervals and on reaching a reference interval value sends maintenance information to the central control unit (134) or an external input and/or output device.

Smart axes and related method

The invention relates to a displacement unit and related method, as described in the preambles of claims 1 and 39.

From DE 41 06 689 A1 a method for controlling a processing machine is known, in particular an assembly machine and similar processing machine. The latter comprises a plurality of workpiece carriers, which are moved past workstations on a moving track or work line in transport direction. The latter are designed respectively for at least one prespecified procedure and are controlled at least partly by an electronic control unit. Each workstation has its own electronic control unit, which is equivalent to the control units of other workstations, whereby the control unit of each workstation only cooperates with the immediately following and/or immediately preceding workstation via a data and control line. At the first workstation an electronic protocol is established for each workpiece carrier, which in addition to an identification identifying or characterising said workpiece carrier contains the work to be performed in transport direction at subsequent workstations. Said protocol is then sent according to the work stages via a data line from the control unit of the preceding workstation to the control unit of the subsequent workstation. The disadvantage of this design is that the individual workstations comprise various different components according to the work to be performed, which excludes the serial manufacture of the various components. In this way it is not possible to produce such an assembly machine using standardised individual components, which is disadvantageous for the manufacturing costs of such an assembly machine. A further disadvantage is that once a production process has been commenced it is not possible to intervene to correct an erroneous protocol for example. Furthermore, the central monitoring or direct programming of a particular workstation is not possible for example with an additional simulation procedure.

The objective of the present invention is to create a displacement unit which is composed of separate standardised components and can be integrated as a standardised component itself into a complete system and thus a modular structure - for example an assembly line - can be created.

The objective of the invention is achieved by means of the features described in the characterising part of claim 1. The surprising advantage is that the control unit is connected directly to the displacement unit and thus expensive installation of wiring can be avoided on the one hand and specific functions of the adjusting unit can be preset without external programming. In this way for example the expense of programming can be reduced considerably and it is possible to produce the transport devices in series as standard units without the special manufacture of parts designed for specific uses being necessary.

A development according to claim 2 is advantageous, whereby it is possible to combine various different designs of switching modules with any control modules.

An embodiment according to claim 3 is also advantageous, whereby information can be gathered centrally from all different parts of the displacement unit.

A development according to claim 4 has proved to be advantageous, which permits the rapid and simple manufacture of a connection.

A further embodiment is described in claim 5 in which information can be transmitted from a central area to the various units of a displacement unit.

If the development according to claim 6 is realised, a rapid and simple line connection can be achieved in relation to outgoing information.

An embodiment according to claim 7 is also advantageous, in which program sequences can be determined directly in the control unit.

The developments according to claims 8 and 9 are advantageous, in which the control unit is small and a rapid transfer of information is ensured.

An embodiment according to claim 10 has the advantage that the control unit is independent of an external power supply and thus the smooth operation of the displacement unit is ensured.

A development according to claim 11 is also possible, in which in a simple manner the device can be adjusted to different situations and thus a high degree of flexibility is achieved.

An embodiment according to claims 12 to 15 has the advantage that the transfer of power and information is performed by robust elements, whereby the maintenance costs of such displacement units is reduced.

A development according to claim 16 is also advantageous, whereby the modular construction of the displacement unit or an assembly system composed of displacement units is improved, which leads in particular to a reduction in assembly costs.

An embodiment according to claim 17 has proved to be advantageous, whereby the connections for the control unit are designed for a modular structure of the displacement unit or assembly unit composed therefrom .

An embodiment according to claim 18 has the advantage that short line lengths and thereby short switching and pulse times can be achieved.

A development according to claim 19 is also possible by means of which the assembly of the switching modules can be performed rapidly and any arrangement of the switching modules in the displacement unit is possible.

A development according to claim 20 is advantageous, whereby each individual switching module can be controlled and monitored individually.

The embodiment described in claim 21 means that the volume of a pneumatic cylinder can be changed as a result of which the latter can be used flexibly and adapted to different conditions.

A development according to claim 22 is advantageous, whereby a precise monitoring and thereby control of the displacement unit is made possible.

An embodiment according to claims 23 and 24 is also advantageous, whereby a precise positioning of a component of the displacement unit is possible, without the mechanical loading on braking a moved part being too great

The developments according to claims 25 to 27 permit a dialogue between an operator and the control unit, preferably directly at the displacement unit.

A variant according to claim 28 is also advantageous, whereby assembly is facilitated and the manufacturing costs are thus considerably reduced.

A development according to claim 29 is also advantageous, whereby expensive cabling and piping is avoided and the assembly costs can be further reduced.

A development according to claims 30 and 31 is advantageous, which reduces the likelihood of disruption on transmitting power or control signals and the number of individual parts in a displacement unit is reduced thus, further improving the modular structure.

A development according to claim 32 is also possible, permitting the simple assembly of the signalling and/or monitoring members on the displacement unit and in addition achieving a flexible arrangement thereof.

The design described in claim 33 has the advantage that information is sent via a central line and thus the cost of wiring is further reduced.

A design according to claim 34 is advantageous, in which an individual signalling and/or monitoring member can be monitored and/or programmed, whereby the possible use of such displacement units is extended by the thus achieved flexibility.

An embodiment according to claim 35 is also advantageous, by means of which the manual entering of data is avoided, and data is picked up automatically, thereby reducing the pulse times of an assembly system comprising several displacement units.

A preferred embodiment is described in claim 36, by means of which the wiring cost is further reduced and even greater distances for transmitting information can be bridged without increasing the likelihood of disrupting the information flow.

By means of the embodiment described in claim 37 it is possible to detect the position of various members in a coordinate system and thus the relative position of two members can also be determined easily.

A variant according to claim 38 is also advantageous by means of which the displacement of a movable element of the displacement unit can be simulated directly without previously expensive mathematical calculations of the function of the displacement being necessary.

The objective of the invention is also achieved by the features described in the characterising part of claim 39. The surprising advantage here is that the comparison of the actual values with the reference values is performed automatically and if the latter differ there is an automatic adjustment of the actual value to the reference value. In this way lengthy setting and adjusting procedures are avoided, and in particular the starting up of such a displacement unit or a system comprising several displacement units is simplified and the time required for this reduced.

An embodiment according to claim 40 is advantageous, whereby even during the operation of the displacement unit or an assembly device comprising several displacement units, a permanent comparison of the reference values with the actual values or the actual values with a target value is performed and during operation there is an adjustment of the actual values to the target values.

A development according to claim 41 has the advantage that the pulse times of the individual displacement units of an assembly device or the components of a displacement unit are determined to a common value which is preferably oriented to the greatest pulse time, so that unnecessary wear due to unnecessary short pulse times is avoided.

An embodiment according to claim 42 is also advantageous, whereby the control unit is able to make decisions and learn independently.

Finally, a development according to claim 43 is advantageous, in which the intervals between two pieces of maintenance information or the intervals of two consecutive activations of the learning mode can be used as criteria for the wear or maintenance of the displacement unit, and thus a maintenance plan can be established which reduces maintenance costs.

The invention is explained in more detail in the following by way of the embodiments illustrated in the drawings.

These show:

Fig. 1 a displacement unit according to the invention, in cross section, in front elevation;

Fig. 2 a section of the displacement unit 1 of the invention, in particular a control unit, in perspective view;

Fig. 3 a section of the displacement unit of the invention, in particular a control unit, in perspective view;

Fig. 4 a further embodiment of the displacement unit of the invention, in cross section, in plan view;

Fig. 5 the displacement unit of the invention, in cross section, along the lines V-V of Fig. 4;

Fig. 6 a further embodiment of the displacement unit of the invention, in front elevation;

Fig. 7 a block diagram of a control unit of the displacement unit of the invention;

Fig. 8 a circuit diagram of the control unit of the displacement unit of the invention;

Fig. 9 a time-motion diagram of the displacement unit of the invention;

Fig. 10 a flowchart of the method of the invention for operating the displacement unit according to the invention;

Fig. 11 a flowchart of the method for operating the displacement unit of the invention;

Fig. 12 a further embodiment of the displacement unit according to the invention, in cross section, in plan view;

Fig. 13 the displacement unit of the invention, in cross section along the lines XIII-XIII of Fig. 12.

First of all it should be noted that in the descriptions of the various embodiments the same parts are given the same reference numbers or component names, whereby the disclosures contained throughout the description can be applied to the same parts with the same reference numbers or the same component names. Also the details relating to position, such as e.g. top, bottom, side etc. relate to the Figure being described at the time and should be transposed to a new position when the position has changed. Furthermore, individual features of the various embodiments shown can represent independent solutions according to the invention.

In Fig. 1 a displacement unit 1 for example for supply, manipulation, joining or control systems of an assembly system for mounting parts 2 is shown. The latter comprises components 3, 4 that can be displaced relative to one another using a drive unit 5, for example by means of compressed air, electricity or hydraulic fluid. Furthermore, the displacement unit 1 comprises at least one guiding device 6 for at least one of the components 3, 4. The displacement unit 1 also comprises a control unit 7, whereby at least one member 8 of the control unit 7 processing logic information and/or bus information and/or a command is integrated into the drive unit 5 and/or into at least one of the components 3, 4 and/or is mounted on one of the components 3; 4.

The control unit 7 comprises at least one control module 9 and/or one or more switching modules 10 allocated to the control module 9. At least one switching module 10 of the control unit 7 is designed for example as a pneumatic valve 11. It can however also be designed as a relay or as a contactor. The control unit 7, in particular the switching modules 10 are con-

nected to the drive unit 5, which is designed for example as a pneumatic drive 12, hydraulic drive, servomotor drive, electric motor drive, manual drive or piezo drive. The pneumatic drive 12 is particularly in the form of an pneumatic cylinder 13. The latter comprises parallel closing elements 14, which can be adjusted relative to one another or can be mounted in a cylindrical pipe 15, whereby the volume and the displacement of the cylinder can be changed. Said cylindrical pipe 15 forms the guiding device 6 in the present embodiment. In component 3, in particular in the cylindrical pipe 15, are signalling and/or monitoring members 16, which are designed for example as limit switches and/or proximity switches 17 and/or as a displacement measuring system and/or position detecting system.

At least one mounting part 2 is located on a transport device 18, which in the present embodiment comprises a drive and/or guiding device 19 and workpiece carrier 20. The drive and/or guiding device 19 comprises for example drive axes 21, which run perpendicular to the transport device and to a central axis 22 of the pneumatic cylinder 13. A drive wheel 23 is arranged on the drive axis 21 and secured thereto and can be made for example of plastic or metal with a plastic coating. Spaced apart from the drive wheel 23 at a distance 24 measured parallel to the drive axis 21 is a guiding wheel 25 which is secured immobily not with the drive axis 21 for example. The guiding wheel 25, in particular a surface 26 thereof is pressed for example by means of elastic force against a flank surface 27 of the workpiece carrier 20 running parallel thereto and at right angles to the drive axis 21, whereby an inner spacing 28 of a recess 29 of the workpiece carrier 20 parallel to the distance 24 corresponds to the distance 24 plus a double wheel width 30.

On an upper side 31 of the workpiece carrier 20 facing away from the recess 29 and facing the displacement unit 1, which upper side is perpendicular to the central axis 22, is a mount 32 attached for example detachably or non-detachably to the upper side 31 in which a mounting part 2 is arranged. The latter is designed as roller 33 made of plastic for example, which has a cylindrical bore 34 in which a bolt 35 also forming a mounting part 2 is to be pressed. Of course, the use of such a displacement unit 1 is not only restricted to transport devices 18 with workpiece carriers 20 or the mounting parts 2 described.

The pneumatic cylinder 13 has a piston 36 forming the component 4, which has a piston surface 37 at right angles to the central axis 22, beyond which a piston rod 38 projects. In an end

region of the piston rod 38 facing away from the piston surface 37 the former comprises in the present embodiment a pressure piece 39, which is screwed onto the piston rod 38 for example, in particular onto a threaded section 40 thereof. In this way the displacement unit 1 in the present embodiment acts as a joining system, in particular as a pressing device for assembly parts.

On an outer surface 41 of the cylindrical pipe 15 is the control unit 7, which is mounted for example on a console 42 connected detachably or non-detachably to the outer surface 41. The switching modules 10 are preferably connected detachably to the console 42 and are formed for example by a 4/2-way-valve 43, two restrictor return valves 44, 45 and two 3/2-way-valves 46, 47. The switching modules 10 comprise for example electrically operated drives 48, which are connected by control lines 49 to the control module 9 illustrated by dashed lines. Of course, it is possible to design the control lines 49 not only as free, i.e. flexible, lines but to integrate them into an electric distribution bar or cable channel. The switching modules 10 are connected according to their switching function for example by lines 50, in particular pneumatic pipes 51. The control unit 7, in particular the control module 9 has inputs 52, for example for signals and/or commands of a central control unit and/or the signalling and/or monitoring members 16 and/or for signals and/or commands of an additional control unit 7 of further displacement units 1 and/or external input and/or output devices and/or drive units 5 and/or power and/or switching modules 10, whereby the inputs 52 are connected for example by single point plugs with single lines, which can also be connected non-detachably to the inputs 52.

The inputs 52 can also be connected by at least one multipoint plug with at least one multipoint line and/or by a bus connector plug 53 to a central connecting line. The control unit 7, in particular the control module 9 can also comprises outputs 54 which permit the output of signals and/or commands to the central control unit and/or the switching modules 10. Furthermore, outputs 54 can be used for example for signals and/or commands to the signalling and/or monitoring members 16 and/or control units 7 of additional displacement units 1 and/or to external input and/or output devices and/or to drive units 5 and/or for power. The output of signals and/or commands can be performed by means of the bus connector plug 53 which also forms an input 52.

The outputs 54 can like the inputs 52 be connected by single point plugs with single lines and/or by one or an additional multipoint plug to one or other multipoint line and/or via one or other additional bus connector plug 53 to one or other additional central connecting line. As shown in Fig. 2 the lines 50 shown in Fig. 1, in particular the pneumatic pipes 51 can be substituted or supplemented by a pneumatic distribution bar 55. The distribution bar 55 has a length 56 and a width 57 perpendicular thereto, which with a height 58 measured perpendicular to the width 57 delimits an end face 59. The latter comprises openings 60 for channels 61 which extend for example over the entire length 56, parallel to the latter and parallel to one another.

On an upper side 62 running perpendicular to the end face 59 and surrounded by the length 56 and the width 57, openings 60 are also provided, preferably for the switching modules 10. Thus for example for the 4/2-way-valve 43 adjacent to the end face 59 on the upper side 62 there are four openings 60 connected to corresponding openings 63 in the switching modules 10. The channels 61 are formed for example by an air inlet channel 64, an air outlet channel 65 and two connecting channels 66, 67. An opening 63 of the 4/2-way-valve 43 is connected to a channel 61 for example by a plug. Spaced apart from the 4/2-way-valve 43 in the opposite direction to the end face 59 is the 3/2-way-valve 46. The latter also comprises openings 63, one of which is connected preferably detachably with the connecting channel 66, and in which the restrictor return valve 44 is arranged. Facing away from the upper side 62 of the pneumatic distribution bar 55 and parallel to the latter the 3/2-way-valve 46 is delimited by an upper side 68, which comprises two openings 63, one opening 63 comprising for example a sound damper 69, whereas the other opening 63 is connected to the pneumatic cylinder 13 shown in Fig. 1. The latter openings 63 can however also be arranged on the underside 70 of the 3/2-way-valve 46 facing the upper side 62 and away from the upper side 68, as a result of which in the pneumatic distribution bar 55 further channels 61 would be necessary.

Spaced apart from the 3/2-way-valve 46 in opposite direction to the 4/2-way-valve 43 is the 3/2-way-valve 47, which is connected by an opening 63 by an opening 60 arranged in the upper side 62 of the distribution bar 55 with the connecting channel 67. Out of the opening 63 a restrictor return valve 45 extends for example inside the 3/2-way-valve 47. There are also openings 63 on the upper side 68 of the 3/2-way-valve 47, whereby one opening 63 has a sound damper 69, and the other opening 63 is connected to the pneumatic cylinder 13 shown

in Fig. 1. A configuration of this kind or connection of switching modules 10 is preferably used for the end position damping of pneumatic cylinder 13 to be explained in more detail.

Of course in this way any arrangement of switching modules 10 and thereby the realisation of various controls can be achieved. Accordingly the number of channels 61 arranged in the pneumatic distribution bar 55 and the switching modules 10 arranged on the pneumatic distribution bar 55 can be varied as desired. It is also possible to integrate the switching modules 10 into the pneumatic distribution bar 55 and not, as shown by way of example, to arrange them detachably or non-detachably on the upper side 62. In addition, the switching modules 10 can also be arranged on or in the cylindrical pipe 15 instead of being arranged on a pneumatic distribution bar 55. In particular at least one component 3; 4 can comprise a pneumatic distribution bar 55.

In Fig. 3 a development of the control unit 7 is shown in perspective view. The latter comprises for example – as described for Fig. 2 – a pneumatic distribution bar 55 which comprises channels 61 and on the upper side 62 of which several switching modules 10 are arranged. The switching modules 10 comprise drives 71 which are connected detachably or non-detachably with the switching module 10 or with an electric distribution bus bar 72 preferably by plugs 74 designed as coupling devices 73. In the present embodiment the electric distribution bus bar 72 is a part of the control unit 7. It is however also possible to form a flexible connection between the electric distribution bus bars 72 and the control unit 7. Also the electric distribution bus bar 72 should not only be understood to be a rigid line connection, but can also be formed by flexible single lines preferably running into a housing.

The control unit 7, in particular the control module 9 comprises in the present embodiment at least one display element 75, which is designed for example as a display 76 with text, number display, light-emitting diodes and/or acoustic information elements. In addition, the control unit 7 can comprise an input device 77, preferably in the form of a keyboard 78. The latter can however also be formed by a touch screen which combines the input device 77 with the display 76. The display element 75 together with the input device 77 forms an input and/or output device 79. The electric distribution bus bars 72 and/or the control unit 7 comprise on an end side face 80 for example a multipoint plug 81 designed as an input 52 and/or output 54. It is also possible to use the bus connector plug 53 described in Fig. 1.

In the jointly described Figs. 4 and 5 a further embodiment of a displacement unit 1 according to the invention is shown. The latter comprises the drive unit 5, which in the present embodiment is designed as a pneumatic cylinder 13 without a piston rod. The pneumatic cylinder 13 without a piston rod in turn comprises a cylindrical pipe 15, which has connection openings 82 which project from the outer surface 41 of the cylindrical pipe 15 up to a cylinder inner chamber 83. The cylindrical pipe 15 is used in turn as a guiding device 6 for the piston 36. This is designed for example to be hollow and comprises two parallel piston plates 84 at right angles to the central axis 22, which are connected detachably or non-detachably to flanges 85 running parallel thereto.

The flanges 85 are a component of a piston body 86, which has a rectangular cross section for example in a plane perpendicular to the central axis 22. The flanges 85 and the piston plates 84 are adjusted in outline to the cross section of the cylindrical inner chamber 83 and are designed to be circular for example, i.e. concentric to the central axis 22. An outer surface 87 delimiting the piston body 86 and parallel to the central axis 22 is used for mounting a slide 88 which passes through a slot-shaped longitudinal opening 89 arranged in the cylindrical pipe 15. The slide 88 comprises a pneumatic distribution bar 55, which is secured detachably or non-detachably to an upper side 90 of the slide 88 perpendicular to the outer surface 87. The slide 88 has a height 91 measured parallel to the outer surface 87 which spaces the upper side 90 from an underside 92 of the slide 88 parallel thereto. The slot height 93 of the longitudinal opening 89 measured parallel to the slide height 91 is greater than the slide height 91 plus the bar height 58 of the pneumatic distribution bar 55. On the upper side 62 of the distribution bar 55 or the electric distribution bus bars 72, which can also be arranged on the upper side 90 of the slide 88, are the switching modules 10. From the switching modules 10 lines 50 run to connection openings 82 of an additional displacement unit 1, which is also designed for example as a pneumatic cylinder 13, but with a piston rod 38.

The slide 88 is delimited in opposite direction to the outer surface 87 of the piston body 86 and thus the component 4 by an end face 94, which has a mechanical interface 95 for additional displacement units 1 and/or assembly and/or processing devices and/or for power and/or for control units 7. In place of lines 50 said mechanical interface 95 can be designed so that the end face 94 or the end face 59 of the pneumatic distribution bar 55 comprises not shown openings which correspond with also not shown openings in the other displacement

unit 1. It is also possible instead of a separate pneumatic distribution bar 55 to design the slide 88 to have integrated channels 61.

On an inner end face 96 of the slide 88 or the pneumatic distribution bar 55 and/or the electric distribution bus bars 72 running parallel to the end face 94 and opposite the latter are inputs 52 and/or outputs 54 which are combined in the present embodiment in the form of a bus line 97. It is also possible however, instead of the bus line 97 to use a multipoint line or single lines. The bus line 97 can be flexible or rigid and runs as far as the piston plate 84 which faces the control unit 7 for the pneumatic cylinder 13 without a piston rod. In said piston plate 84 there are inputs 52 and/or outputs 54 which are designed for example as coupling devices 98. From said coupling devices 98 up to the adjacent closing element 14 of the pneumatic cylinder 13 without a piston rod extend one or more control lines 49 and/or one or more lines 50 which are designed to be adjustable in length for example in the form of a spiral.

On an outer surface 99 of the closing element 14 facing away from the piston 36 are coupling devices 98, which are allocated to the control lines 49 and/or lines 50.

The control line 7 is also arranged on the outer surface 99. The latter also comprises a display 76 and/or a keyboard 78. The control unit 7, in particular the control module 9 has inputs 52 and/or outputs 54, which also can be designed as coupling devices 98 and are used for the transmission of signals and/or commands for example to a central control unit. This transmission is however not necessarily possible only by means of lines 50 or control lines 49, but can also be performed for example optically by means of lasers or for example by means of infrared or ultrasound. From the control module 9 extends an ASIC bus line 100 for example, which supplies the switching modules 10 or the signalling and/or monitoring members 16 with power and/or data or conveys data from the latter. The ASIC bus line 100 is preferably bipolar. Via an interface 101 and/or via an evaluation unit 102 the signals and/or commands originating from the control module 9 and/or the central control unit and transmitted by the ASIC bus line 100 are transmitted to an electric distribution bus bar 72 which is arranged in a guiding device 103.

The guiding device 103 is preferably arranged in the cylindrical pipe 15 and extends for example at least over a portion of a length 104 of the drive unit 5. It is thus designed so that it

projects groove-like over the outer surface 41 of the cylindrical pipe 15 in opposite direction to the piston 36. In the region of the outer surface 41 it has a slot width 105, which is arranged symmetrically about a central plane 106 running through the central axis 22. At a depth 107 measured from the outer surface 41 in opposite direction to the piston 36 the guiding device 103 comprises a groove 108, which has a width 109 parallel to the slot width 105 and perpendicular to the central plane 106 which is greater than the slot width 105. The groove 108 has a height 110 measured adjoining the depth 107 in opposite direction to the piston 36. In addition to the groove height 110 the guiding device 103 also comprises a recess groove 111 which has a width 112 measured parallel to the groove width 109 that is smaller than the latter.

The cylindrical pipe 15 also comprises connection openings 82 projecting from the outer surface 41 in the direction of the inner chamber of the cylinder 83. Symmetrically about the central plane 106, a bore distance apart 113 channels 61 run in the cylindrical pipe 15, in particular an air inlet channel 64 and an air outlet channel 65. From the latter connecting channels 114 extend up to the groove 108 and run at right angles to the outer surface 41.

Switching modules 10 are inserted into the guiding device 103 which in the present embodiment as designed as valve cartridges 115. Said switching modules 10 comprise for example a flange 116 with contact elements 117 which are in contact with the electrical distribution bus bar 72. The electric distribution bus bar 72 which in the present embodiment is designed as a conductor can however also be in the form of lines integrated into the component 3, i.e. in the cylindrical pipe 15. In addition, it is also possible for the switching module 10, in particular the valve cartridge 115, to have a separate control module 9, which is provided either in addition to the control module 9 arranged on the closing element 14 or replaces the latter.

The guiding device 103 also forms a bar-shaped securing device 118 for the signalling and/or monitoring members 16. These can also comprise control modules 9. It is also possible not to integrate the guiding device 103 into the drive unit 5, i.e. into the cylindrical pipe 15, but to design it as a separate component, which is secured detachably or non-detachably to the drive unit 5, in particular the cylindrical pipe 15. In this way the guiding device 103 can comprise several connection openings arranged at prespecified distances in the direction of the length 104, at least one of which corresponds with connection openings 82 arranged in the cylindri-

cal pipe 15, i.e. in the drive unit 5. In this way it is possible to design the guiding device 103 for a modular structure of the displacement unit 1.

In Fig. 6 a further embodiment of a displacement unit 1 according to the invention is shown. The latter comprises components 3, 4 that are adjustable relative to one another, whereby component 4 is arranged by means of a guiding device 6 designed for example as a linear guide 119 on the preferably frame-shaped component 3. The guiding device 6 can however also be designed as a rotary and/or gear guide for example or as a sliding track. The frame-shaped component 3 for example has two parallel connecting elements 120, which are spaced apart by longitudinal elements 121 running at right angles and parallel to one another. The connecting elements 120 are used for mounting securing devices 122 which are formed for example by a damping device 123, in particular a shock absorber 124. In this way the component 4 is restricted in at least one direction of movement on the component 3. Signalling and/or monitoring members 16 are also arranged in the connecting elements 120, which are designed for example in the form of capacitive proximity switches 17.

The guiding device 6 is designed for example as a ball bush guide whereby the component 4 has at least one ball bush 125, in which a guide shaft 126 is inserted, which is arranged securely on the component 3. A longitudinal element 121 comprises for example the drive unit 5 which in the present embodiment is also designed as a pneumatic cylinder 13.

Said pneumatic cylinder 13 is designed as a linear cylinder and comprises the slide 88 on which component 4 is secured. The latter comprises in turn the interface 95, on which for example a not shown additional displacement unit 1 can be arranged and in the region of which also not shown inputs 52 and/or outputs 54 of a control unit 7 can be arranged, which can be line connected by plug connections to a control unit 7 of a not shown additional displacement unit 1. Integrated into the drive unit 5 or the component 4 is the pneumatic distribution bar 55 and/or the electric distribution bus bar 72 with the control module 9. The electric distribution bus bar 72 is connected by dot-dash shown control lines 49 to signalling and/or monitoring members 16 and the pneumatic distribution bar 55 via lines 50, for example pneumatic pipes 51 to the switching modules 10.

As shown for example in the jointly described Figs. 7 to 9, the control module 9 is in the form of a microprocessor 127 for example, which is connected by conductors 128 forming control lines 49 to an interface 129 forming an input 52 and/or output 54. The latter comprises an integrated or, as shown, an external evaluation unit 130 which is also connected to the microprocessor 127. In addition, a memory 131 for saving, in particular individual movements, and an input 52 and/or output 54 designed as an external interface 129 for external input and/or output devices 79 are connected to the microprocessor 127. In addition the microprocessor 127 can also be connected to a driver 132 which is arranged between outputs 54 and the microprocessor 127 and to a D/A converter 133 which is arranged between inputs 52, in particular for measuring members and/or signalling and/or monitoring members 16 and the microprocessor 127. The microprocessor 127 is designed so that it detects one or more of the following functions in parallel or in series:

- initialisation mode
- control mode
- learning mode
- monitoring mode

Of course, it is possible to provide a separate microprocessor 127 for each of these functions to perform these functions using a conventional control or perform them in a central control unit 134.

The initialisation mode is used so that on forming the connection between the control module 9 and the control unit 134, the basic parameters of the control module 9 or the displacement unit 1 are transmitted. The latter can for example be transmitted in the form of a program which makes the potential reference values of the displacement units 1, in particular the pneumatic cylinder 13, appear on an external input and/or output device 79 or on a screen of the control unit 134. Said potential reference values, such as example displacements in x and y direction, speeds and forces can therefore be stored in the memory 131. The operator can now determine the actual, i.e. current reference values, for example the displacement, the acceleration, the deceleration of the piston 36 of the pneumatic cylinder 13, according to the individual movement situation. This can be performed for example in such a way that by means of the input and/or output device 79 or by means of the control unit 134, the potential

reference values can be shown as variables, which can be provided by the operator with the corresponding current reference values. If the current reference value entered by the operator exceeds the stored potential reference value, a warning can be sent to the operator for example.

Such an initialisation of a displacement unit 1 can however also be performed by means of a data glove and simulation of the displacement unit 1 directly at the control module 9. In this case the operator with the data glove executes the movement to be performed directly in the relevant assembly station.. The displacement unit 1 performs these movements of the data glove preferably simultaneously and transmits the values detected by measuring members and/or the signalling and/or monitoring members 16, for example x and y components, to the microprocessor 127 and/or to the control unit 134, whereby the data glove is connected couplably by inputs 52 and/or outputs 54 to the control unit 7 and/or the control unit 134, and the movement data conveyed to the latter. The latter calculate from this a function of the movement and store it as a program. In particular by using a data glove as an input and/or output device 79 the expense of programming can be considerably reduced and the displacement unit 1 can be used variably accordingly. The x and y components can however also be detected by a local positioning system similar to the GPS. Thus for example when producing not shown different mounting parts 2 on an assembly device for each individual mounting part 2 and each individual displacement unit 1 a corresponding program can be developed rapidly and saved. The input and/or output device 79 can however also be designed as a keyboard, a reading device for chipcards, magnetic cards, CDs, diskettes or tapes.

The other control modules 9 or displacement units 1 can be initialised in the same way. On using a bus line system the control module 9 following the already initialised control module 9 can be connected to the former via the not shown bus line 97. In this case the potential reference values are sent to the central control unit 134 avoiding the preceding control module 9. The operator can now also determine the actual reference values for this additional control module 9, which can be stored in the control unit 134 or in the memory 131 as data or in program form. In this manner for each individual control module 9 the corresponding handling program can be provided.

As however in many cases the activation of a control module 9 can be dependent on the handling parameter of another control module 9, it is also necessary to connect the individual handling programs of the control modules 9. This can be performed by means of the control unit 134 and/or the control modules 9 themselves. For this purpose for example after the initialisation of a control module 9, i.e. after determining the current reference values, the latter can ask in a dialogue with the operator „Start signal?“ This start signal is a freely definable variable used by the operator. The operator can use a signal of a different displacement unit 1 in that this other displacement unit 1, i.e. the other control module 9, creates a monitoring signal, which is sent from the signalling and/or monitoring members 16 of this other displacement unit 1 via for example the D/A converter 133, and via the interface 129 as a data bus addressed to the displacement unit 1 needing the start signal, which data bus is used in the variable „start signal?“. A connection of this kind of various control modules 9, i.e. various displacement units 1, can also be performed however via the input and/or output device 79 of a control module 9.

The control mode is carried out as follows.

The interface 129 is connected to a central connection line 135, which is designed as a serial or parallel bus line 136 and leads to at least one control unit 134 and additional displacement units 1. From the control unit 134 and/or from one or more additional control modules 9 the interface 129 receives one or more data sets provided with an address. In the evaluation unit 130 a comparison of these addresses is made with the address of the control module 9, whereby when the addresses coincide the control module 9 is supplied with the transmitted data set. A data set of this kind can in the present example merely be a starting pulse for the control module 9 and thus for the displacement unit 1 concerned, which is transmitted for example from a control module 9 of a different displacement unit 1, which has completed its tasks.

In this case, as already described above, the operator by means of the control unit 134 or an external input and/or output device 79 can instruct the microprocessor 127 of the control module 9 of this other displacement unit 1, to enter a signal received by a signalling and/or monitoring member 16, for example a position of the pneumatic cylinder 13 via the interface 129 to a control module 9 of a displacement unit 1 addressed into the bus line 136, whereby

this signal reaches the interface 129 of the control module 9 of the displacement unit 1 and is fed into the microprocessor 127 of this control module 9 where it is used as a starting pulse for the program for this displacement unit 1 determined by the operator after the initialisation mode in the memory 131 of the control module 9 or in the central control unit 134.

With the arrival of the start pulse in the microprocessor 127 its program begins to run. In this case by means of the driver 132, if there is one, one or more switching modules 10 are charged by one or more control lines 49, so that for example a coil designed as a drive 48 of the switching modules 10 is flowed through with current and a valve body is moved by means of magnetic force. In this way for example by means of the connection opening 82 of the pneumatic cylinder 13 shown in Fig. 4 the latter is charged with compressed air and operates for example at constant speed. It is also possible however instead of conventional pneumatic valves 11 to use servovalves and thus vary the speed of the piston 36.

If the piston 36 now reaches a position which can be detected by means of the measuring member and/or the signalling and/or monitoring member 16 shown in Fig. 4 and/or prespecified in the program of the microprocessor 127, a pulse arrives via a control line 49 to the microprocessor 127, which sends a corresponding signal to the switching module 10, i.e. to the drive 48 of a pneumatic valve 11, and for example ends the air supply to the pneumatic cylinder 13 and stops its movement. Of course, however the evaluation of sensors 137 designed as signalling and/or monitoring members 16 can also be performed in the control unit 134 and the drive or charging of individual actuators 138 of a displacement unit 1 can be performed directly via the central bus line 136. In addition, the switching and control procedures should not be understood to be restrictive and only represent a simple example of a control module 9. Furthermore, data can be transmitted between the control unit 7 and control unit 134 and/or from the individual components of the control unit 7 to the latter optically by means of lasers or for example by means of infrared or ultrasound.

As already explained the control module 9 also has a learning mode. In this case, as already shown in the control mode, for example a position to be reached by the piston 36, i.e. a reference value in the program of the microprocessor 127 designed as logic element 139 is predetermined and detected for example by means of a measuring member, in particular a displacement measuring device.

Once the piston 36 reaches this position the corresponding pulse of a displacement measuring device forming a signalling and/or monitoring member 16 is evaluated in the microprocessor 127, and the required pulse is sent to the switching module 10, which stops the supply of power to the drive unit 5. Due to the kinematic energy of the piston 36 however, despite ending the air supply, the piston 36 may move beyond the given position, which can affect the precision of positioning the displacement unit 1.

By means of the displacement measuring device the actual position, i.e. the actual value of the displacement unit 1, in particular the stopped piston 36 is detected, and sent to the microprocessor 127 and/or the central control unit 134, where the actual value is compared with the reference value and the difference between the reference position and the actual position of the piston 36 is determined. After determining the difference the microprocessor 127 sends a pulse for opening a switching module 10, whereby the piston 36 is moved back by the difference for example restricted, and thus the exact position is reached, i.e. the actual value is adjusted to the reference value. This difference is also used for the next displacement cycle, in order to actuate the switching module 10 not just when reaching the reference position, but earlier by the calculated difference. This means that the actual value is defined as the reference value which represents an optimised time value for example with respect to cycle time, wear, vibration etc. A learning mode of this kind is advantageous in particular for increasing the acceleration of the piston 36 and a corresponding damping, i.e. slowing down of the piston 36. The advantage of such a learning function is in particular that on using servovalves the pistons 36 of the pneumatic cylinder 13 are accelerated or slowed down, and in this way there is a change in the kinematic energy of the piston, which makes the deceleration of the piston more difficult to an exact position.

A further example of the learning mode can on using corresponding sensors 137, in particular microsensors, reduce the loading and thereby the wear of the displacement unit. Thus for example, as shown in Fig. 1, on the tool carrier 20, in particular on its upper side 31 a vibration sensor designed as a signalling and/or monitoring member 16 can be provided, which transmits its data wirelessly or by line to the control module 9 and/or to the control unit 134. A vibration sensor and/or force sensor of this kind can however also be arranged on the displacement unit 1 for example on component 3 and/or component 4.

If for example after the initialisation mode the first cycle of the displacement unit 1 is performed and as shown in Fig. 1 for example, a gripper with a mounting part 2 drives too „hard“ on the tool carrier 20 or a mount 32 for the mounting part 2, the vibration sensor transmits the value of the vibration to the control module 9 and/or the control unit 134. The latter evaluate the measurement value and on exceeding a specific predeterminable target value, for example by means of calculating algorithms such as fuzzy logic, neuronal networks or genetic algorithms, calculate a new end position of the gripper, which on reaching the mounting part 2 is no longer placed „so hard“ into the mount, which is achieved preferably by the end position damping described below. The relative number of cycles between two consecutive adjustments of the positions of the components 3, 4 can be used to determine a maintenance plan. In this way it is possible on the basis of the predeterminable reference value to determine an optimum drive curve of the displacement unit 1 and to control the switching modules 10 accordingly.

It is also possible however to detect wear by measuring pressure and thus establish maintenance prognoses. Thus for example on initialisation the pressure in the air inlet line of the pneumatic cylinder 13 is determined by a pressure sensor and saved in the memory 131. The actual pressures are detected cyclically. Due to wear, for example in the region of the piston 36 and the cylindrical pipe 15, or the linear guide 119 designed as a guiding device 6 and illustrated in Fig. 6 the sliding friction is reduced, which results in a reduction of frictional forces and thereby directly to a reduction in pressure. This drop in pressure thus signals the degree of wear of the elements concerned, and can, as already described, be used as parameters for the modes of the displacement unit 1.

By means of the also provided monitoring mode for example an exact maintenance and up-keeping of the displacement unit 1 can be performed. The microprocessor 127 counts for example the absolute number of performed cycles and the relative cycle number between two consecutive corrections of the parameters on the basis of the learning mode. If the relative cycle number drops so far that it falls below a predeterminable minimum cycle number the microprocessor 127 sends a repair signal either directly to the control unit 134 or via the external interface 129 to external input and/or output devices 79. The repair signal is set in a relation to the absolute cycle number and a maintenance plan for the future can be developed therefrom.

Of course, the wear can also be determined directly for example by surface roughness measurements and/or by continual measuring of the objects, for example the piston 36 or the sealing rings. Mainly in the areas of control and learning mode specific displacement modes for the displacement unit 1 such as a for example „normal drive“, „slow drive“ or „rapid drive“ can be predetermined by positioning paths and speed profiles 140.

The functions of the displacement unit 1 are now explained with reference to a control shown in Fig. 8 for variable speeds and end position damping of a piston 36 in a predeterminable position.

The starting point here is the available displacement time of a displacement unit 1 resulting from the cycle time of an assembly system, in particular a double acting pneumatic cylinder 13. The latter should be 70 ms for example. As illustrated better in Fig. 9 the speed profile 140 is formed therefrom. The pneumatic cylinder 13 is charged with compressed air on one side 142 at the time point and/or at position 141. The compressed air comes from a central or decentral compressed air supply 143, which is connected to an electrically operated 4/2 valve 144 formed as a switching module 10. The electrically operated 4/2-way-valve 144, for example the drive 145 designed as a coil is connected by a control line 49 and the driver 132 to the microprocessor 127, which via the interface 129, the evaluation unit 130 and the bus line 136 receives the starting signal from the control unit 134 or a control module 9 of a different displacement unit 1.

By means of this starting signal the 4/2-way-valve 144 is switched and a line 146 put under pressure. In this case a restrictor return valve 147 designed as a switching module 10 is released in flow direction to the pneumatic cylinder 13 and the compressed air reaches an electrically operated 3/2-way-valve 148 unrestrictedly. A drive 149 of this valve is connected by a separate control line 49 or via the control line 49 of the 4/2-way-valve 144 to the microprocessor 127 and is inactivated on the advance of the piston 36, so that a free passage of the compressed air is provided to side 142.

At the same time (as the time point or position 141) with the starting pulse at the 4/2-way-valve 144 a pulse is sent via a control line 49 to a further 3/2-way-valve 150, for example just by microprocessor 127 and not by the control unit 134, which is connected to the side 151 of

the pneumatic cylinder 13 and in this activated state the side 151 is completely deaerated for example by means of a sound damper 152. The piston 36 can now be accelerated with full pressure on side 142 and at a given time point 153 in the microprocessor 127 or in the control unit 134 reaches position 154. At time point 153 the pulse from the microprocessor 127 to the additional 3/2-way-valve 150 is switched off, whereby the latter is moved back for example activated by spring force into its position of rest and the outlet of compressed air from the side 151 is performed no longer by a sound damper 152 but by counter pressure by a further restrictor return valve 155, as a result of which the piston speed is reduced until position 156 is reached.

At position 156 either a holding time begins not shown in Fig. 10, during which an additional displacement unit 1 arranged for example on the piston rod 38, completes its task, or the return motion of the piston 36 is performed. For this the pulse on the drive 145 of the 4/2-way-valve 144 is removed, whereby the latter adopts a position of rest due to the spring force. In the latter the air flows into a line 157 in the direction of side 151. Here the restrictor return valve 155 is flowed through unrestrictedly in the direction of the second 3/2-way-valve 150, the drive 149 of which is not charged and thus compressed air reaches the side 151.

At the same time at position 156 by the microprocessor 127 a pulse is sent to the drive 149 of the first 3/2-way-valve 148 and activates the latter, as a result of which the side 142 is completely deaerated by a sound damper 152. The piston 36 now moves at maximum speed from position 156 to position 158. On reaching position 158 the pulse, i.e. the tension on the drive 149 of the first 3/2-way-valve 148 is removed, as a result of which the latter is returned by spring force into its position of rest, and frees the path in the direction of the first restrictor return valve 147, whereby the compressed air emerging from side 142 is restricted and the piston 36 is braked. Both in position 141 and in position 156 – as shown in Fig. 6 – securing devices 122 for example in the form of switchable end stops can be arranged, which themselves can act as signalling and/or monitoring members 16 or comprise additional signalling and/or monitoring members 16. If one is arranged at position 141, for example a pulse is sent via a separate control line 49 or a central connecting line 135 to the microprocessor 127, which conveys this signal via the evaluation unit 130 and the interface 129 to the control unit 134 and/or processes its into a pulse, in which it ends the program stored in the memory 131.

Of course, instead of the time control there can be a displacement measurement in the drive unit 5 and according to predeterminable positions the described pulses can be generated and distributed. The said switching modules 10, i.e. the 4/2-way-valve 144, the 3/2-way-valves 148, 150 and the restrictor return valves 147, 155 are only examples, and can of course be substituted and/or supplemented according to different control functions by different switching modules 10.

One problem with the individual modes is creating a reference parameter which forms the starting point for joining the individual control modules 9 or displacement units 1. A reference parameter of this kind can for example be the speed of a pneumatic cylinder 13 and thus the cycle time of a displacement unit 1. In this case after the initialisation mode the cycle time of each individual displacement unit 1 can be determined and for example sent into the central control unit 134. There a comparison of all cycle times of the displacement units 1 is performed and the „slowest“ displacement unit 1 is determined, i.e. the greatest pulse time of the displacement unit 1 is established. To this cycle time the cycle times of the other displacement units 1 are coordinated for example by means of the learning mode.

In the jointly described Figs. 10 and 11 the sequence of the initialisation mode is shown in combination with the learning mode for optimising reference valves with respect to the cycle time. If an assembly system is to be composed of several not shown displacement units 1, method step 159 is commenced. In the latter there is a selection of a physical target variable in the central control unit 134 shown in Fig. 7 and/or in the control module 9 to be optimised from a specific number of such physical target variables. The latter can for example be the maximum speed, the minimum impact or the necessary speed. The necessary speed of a displacement unit 1 is oriented to each displacement unit 1 which takes the greatest time for a specific assembly step to be performed thereby for procedural reasons. As this slowest displacement unit 1 determines the cycle time of the entire assembly system it is not necessary that other displacement units 1, which are „faster“ than the „slowest“ displacement unit 1 perform the assembly steps to be performed thereby in their minimum possible individual cycle time.

If the individual cycle times, i.e. the individual speeds of the various displacement units 1 are adjusted to those of the „slowest“ displacement unit 1, in this way unnecessary wear can be

avoided in the potentially faster displacement units 1. After method step 159 sequence 160 is performed. In the latter the connection between the central control unit 134 and the first displacement unit 1 or the first control module 9 is formed for example by means of the bus line 136. After this procedure 161 is performed. In the latter the potential reference values of the displacement unit 1 determined in the control module 9 especially in the memory 131 for example maximum displacements in x and y direction are sent to the central control unit 134 automatically by producing the connection in sequence 160. After this follows method step 162, in which now the actual reference values of the displacement unit 1 or the control module 9 adjusted to the corresponding assembly situation of the displacement unit 1 are pre-given at the central control unit 134 or for example at an external input and/or output device 79. Once the method step 162 has been completed sequence 163 is performed which is formed by the learning mode.

The latter is illustrated in more detail in Fig. 11. The learning mode begins with procedure 164, in which the control module 9 programmed with reference values or the displacement unit 1 is started manually and externally, followed by method step 165. In the latter the switching modules 10 of the displacement unit 1 are actuated according to the entered actual reference values. Once the switching modules 10 have ended their prespecified sequences and thus the displacement unit 1 for example has reached its reference position according to the reference values, in sequence 166 the actual values are detected, i.e. for example the actual positions of the components 3, 4 of the displacement unit 1. Afterwards in procedure 167 a comparison of the detected actual values with the entered reference value is made and where there is insufficient correspondence there is a return to the beginning of method step 165 and thus a further actuation of the switching modules 10 and a change of position of the elements e.g. the components 3, 4 of the displacement unit 1 is performed. If the reference-actual value comparison is successful in procedure 167, i.e. the actual values correspond with the reference values, the actual target variable of the relevant displacement unit 1 are stored in the sequence 168. Which target variable should be stored from a possible number of actual target variables is determined by the selection made in method step 159 of the physical target variable to be optimised.

After completing the learning mode of the individual displacement units 1 in method step 169 it is queried whether the method step 159, the sequence 160, the procedure 161, the method

step 162 and the sequence 163 has been performed for all control modules 9 or all displacement units 1. If this is not the case, there is a return to the beginning of sequence 160, whereby the previously described sequence is carried out for a further control module 9 or a further displacement unit 1. However, if all control modules 9 or displacement units 1 are initialised in this way or the latter have learnt their optimum settings, in procedure 170 the common target value of all displacement units 1 is detected from the amount of actual target values of individual displacement units 1 detected and stored in the sequence 163.

Said target value can for example, as already indicated, be the pulse time of the „slowest“ displacement unit 1, which determines the necessary speed for all displacement units 1. In procedure 171 beginning with the first displacement unit 1, a comparison of the actual-target variable is made with the target value. If the latter do not correspond method step 172 is performed, which is formed for example by sequence 163 i.e. by the learning mode. After completing the learning mode i.e. after ending sequence 163 and adjusting the actual values of the displacement unit 1 to the target value procedure 171 is carried out, i.e. a comparison of the actual target variable of the first displacement unit 1 with the target value. If these two do not coincide there is a return to the beginning of method step 172, i.e. to the learning mode. If the comparison is successful however, i.e. the latter coincide, it is queried in sequence 173, whether all actual target variables of all displacement units 1 or all control modules 9 have been compared and adjusted by means of procedure 171 with the target value.

If this is not the case there is a return to the beginning of procedure 171, where now the actual target variable of an additional displacement unit 1 is compared with the target value. If the actual target variable corresponds with the target value, which are compared in procedure 171, the process continues to the beginning of sequence 173. However, if in sequence 173 it is found that all actual target variables of all displacement units 1 or control modules 9 have been compared with the target value procedure 174 is commenced, i.e. the control mode and/or the monitoring mode commences for example, whereby the assembly system is started.

It should also be mentioned that method steps 159, 162, 165, 169, 172 and/or sequences 160, 163, 168, 170 and/or procedures 161, 164, 167, 170 can be preset in the central control unit 134 and in an individual control module 9 of a displacement unit 1 or in several control modules 9 and several displacement units 1.

In the jointly described Figs. 12 and 13 a further embodiment of the displacement unit 1 according to the invention is shown. The latter is basically the same as the displacement unit 1 shown in Figs. 4 and 5. The displacement unit 1 comprises adjacent to the outer surface 41 signalling and/or monitoring members 16 and switching modules 10. The signalling and/or monitoring members 16, which can have separate control modules 9 and/or logic elements 139, preferably have contacting openings 175 arranged symmetrically about the central plane 106, which forms a line connection to a bus line 136, comprising for example two individual conductors 176, which forms the electric distribution bus bar 72. The bus line 136 can however also be designed as a 3-conductor system, one conductor of which is designed as an emergency off conductor by means of which the power supply of all actuators 138 is interrupted. In this case the signalling and/or monitoring member 16 comprises for example an initiator element 177, an electronic module 178 forming a logic element 139 connecting the latter and connecting lines 179 from the electronic module 178 to the contacting openings 175 via which the received signals are transmitted from the initiator element 177 to the bus line 136.

The switching modules 10 also do not have the shown contacting openings 175 by which the latter are supplied with power via the bus line 136. The bus line 136 has for example a circular cross section, whereby it is possible to change both the switching modules 10 and the signalling and/or monitoring members 16, in particular their position as desired along the displacement unit 1. It is also possible however to integrate the bus line 136 into lines 50, in particular into a pneumatic pipe 51 for the switching modules 10.

Finally, it should be noted that in the embodiments described above individual parts have been enlarged disproportionately in order to improve understanding of the solution of the invention. Furthermore, individual parts of the previously described combinations of features of the individual embodiments can form independent solutions according to the invention in connection with other individual features from other embodiments.

The objectives and solutions relating thereto according to the invention can be taken from the detailed descriptions of these Figures.

List of Reference Numbers

- | | |
|---|--------------------------------|
| 1. Displacement unit | 41. Outer surface |
| 2. Mounting part | 42. Console |
| 3. Component | 43. 4/2-way-valve |
| 4. Component | 44. Restrictor return valve |
| 5. Drive unit | 45. Restrictor return valve |
| 6. Guiding device | 46. 3/2-way-valve |
| 7. Control unit | 47. 3/2-way-valve |
| 8. Member | 48. Drive |
| 9. Control module | 49. Control line |
| 10. Switching module | 50. Line |
| 11. Pneumatic valve | 51. Pneumatic pipe |
| 12. Pneumatic drive | 52. Input |
| 13. Pneumatic cylinder | 53. Bus connector plug |
| 14. Closing element | 54. Output |
| 15. Cylindrical pipe | 55. Distribution bar |
| 16. Signalling and/or monitoring member | 56. Bar length |
| 17. Proximity switch | 57. Bar width |
| 18. Transport device | 58. Bar height |
| 19. Drive and/or guiding device | 59. End face |
| 20. Workpiece carrier | 60. Opening |
| 21. Drive axis | 61. Channel |
| 22. Central axis | 62. Upper side |
| 23. Drive wheel | 63. Opening |
| 24. Distance | 64. Air inlet channel |
| 25. Guiding wheel | 65. Air outlet channel |
| 26. Surface | 66. Connecting channel |
| 27. Flank surface | 67. Connecting channel |
| 28. Inner spacing | 68. Upper side |
| 29. Recess | 69. Sound damper |
| 30. Wheel width | 70. Underside |
| 31. Upper side | 71. Drive |
| 32. Mount | 72. Distribution bus bar |
| 33. Roller | 73. Coupling device |
| 34. Bore | 74. Plug |
| 35. Bolt | 75. Display element |
| 36. Piston | 76. Display |
| 37. Piston surface | 77. Input device |
| 38. Piston rod | 78. Keyboard |
| 39. Pressing piece | 79. Input and/or output device |
| 40. Threaded section | 80. End side face |

81.	Multipoint plug	121.	Longitudinal element
82.	Connection opening	122.	Securing device
83.	Cylinder inner chamber	123.	Damping device
84.	Piston plate	124.	Shock absorber
85.	Flange	125.	Ball bush
86.	Piston body	126.	Guide shaft
87.	Outer face	127.	Microprocessor
88.	Slide	128.	Conductor
89.	Longitudinal opening	129.	Interface
90.	Upper side	130.	Evaluation unit
91.	Slide height	131.	Memory
92.	Underside	132.	Driver
93.	Slot height	133.	D/A converter
94.	End face	134.	Control unit
95.	Interface	135.	Central connection line
96.	Inner end face	136.	Bus line
97.	Bus line	137.	Sensor
98.	Coupling device	138.	Actuator
99.	Outer face	139.	Logic element
100.	Bus line	140.	Speed profile
101.	Interface	141.	Position
102.	Evaluation unit	142.	Side
103.	Guiding device	143.	Compressed air supply
104.	Length	144.	4/2-way-valve
105.	Slot width	145.	Drive
106.	Central plane	146.	Line
107.	Depth	147.	Restrictor return valve
108.	Groove	148.	3/2-way-valve
109.	Groove width	149.	Drive
110.	Groove height	150.	3/2-way-valve
111.	Recess groove	151.	Side
112.	Groove width	152.	Shock absorber
113.	Bore spacing	153.	Time point
114.	Connecting channel	154.	Position
115.	Valve cartridge	155.	Restrictor return valve
116.	Flange	156.	Position
117.	Contact element	157.	Line
118.	Securing device	158.	Position
119.	Linear guide	159.	Method step
120.	Connecting element	160.	Sequence

- 161. Procedure
- 162. Method step
- 163. Sequence
- 164. Procedure
- 165. Method step

- 166. Sequence
- 167. Procedure
- 168. Sequence
- 169. Method step
- 170. Procedure

- 171. Procedure
- 172. Method step
- 173. Sequence
- 174. Procedure
- 175. Contacting opening

- 176. Individual conductor
- 177. Initiator element
- 178. Electronic module
- 179. Connection line

C l a i m s

1. Displacement unit, for example for supply, manipulation, joining or control systems of mounting parts with components that can be adjusted relative to one another by means of a drive unit and with at least one guiding device for at least one of the components and a control unit, characterised in that at least one member (8) of the control unit (7) used for processing logic information or bus information (command) is integrated into the drive unit (5) and/or into at least one of the components (3; 4) and/or is mounted on one of the components (3; 4).
2. Displacement unit according to claim 1, characterised in that the control unit (7) comprises at least one control module (9) and/or one or more switching modules (10) assigned to the control module (9).
3. Displacement unit according to claim 1 and/or 2, characterised in that the control unit (7), in particular the control module (9) and/or the switching modules (10), comprises inputs (52), for example for signals and/or commands of a central control unit (134) and/or the switching module (10) and/or the signalling and/or monitoring members (16) and/or control units (7) of further displacement units (1) and/or external input and/or output devices (79) and/or drive units (5) and/or power.
4. Displacement unit according to one or more of the preceding claims, characterised in that the inputs (52) are connected by single point plugs with single lines and/or by at least one multipoint plug with at least one multipoint line and/or are connected by a bus connector plug (53) to a bus line (97) designed as a central connection line.
5. Displacement unit according to one or more of the preceding claims, characterised in that the control unit (7), in particular the control module (9) and/or the switching modules (10), comprises outputs (54), for example for signals and/or commands to the central control unit (134) and/or to the switching modules (10) and/or to the signalling and/or monitoring members (16) and/or to control units (7) of additional displacement units (1) and/or to external input and/or output devices (79) and/or to drive units (5) and/or for power.

6. Displacement unit according to one or more of the preceding claims, characterised in that the outputs (54) are connected by single point plugs to single lines and/or via one or an additional multipoint plug to one or an additional multipoint line and/or via one or an additional bus connector plug (53) to one or an additional central connection line.

7. Displacement unit according to one or more of the preceding claims, characterised in that the control unit (7), in particular the control module (9) has a memory (131) for storing, in particular individual movements.

8. Displacement unit according to one or more of the preceding claims, characterised in that the control unit (7), in particular the control module (9), has a logic unit comprising at least one logic element (139), which forms the member (8), which processes logic information and/or commands and/or bus information, for example for determining and/or monitoring the positions of the components (3; 4) and/or the displacement parameters of the drive unit (5).

9. Displacement unit according to one or more of the preceding claims, characterised in that the logic element (139) of the control unit (7), in particular the control module (9) is designed as a microprocessor (127) which is connected by conductors (128) or flexible control lines (49) with for example an interface (129) for the bus connector plug (53) and/or an evaluation unit (130) and/or a memory (131) and/or an external interface (129) and/or a driver (132) and/or a D/A converter (133).

10. Displacement unit according to one or more of the preceding claims, characterised in that the control unit (7) has a control power source, in particular a battery, an accumulator and/or an interface for an external power source.

11. Displacement unit according to one or more of the preceding claims, characterised in that at least one logic element (139) is designed as an electronic module, for example a microprocessor (127) or a PC or SPS.

12. Displacement unit according to one or more of the preceding claims, characterised in that at least one switching module (10) and/or one logic element (139) is designed for example as a pneumatic valve (11) and/or relay and/or contactor.

13. Displacement unit according to one or more of the preceding claims, characterised in that the control unit (7), in particular the switching module (10) is connected to at least one drive unit (5) designed for example as a pneumatic drive (12), hydraulic drive, servomotor drive, electric motor drive, manual drive or piezo drive.

14. Displacement unit according to one or more of the preceding claims, characterised in that the drive unit (5) has one or more transmitting elements which are connected to at least one component (3;4) and which are in the form for example of couplings, toothed belts, racks, spindles, gears or links.

15. Displacement unit according to one or more of the preceding claims, characterised in that component (4) is arranged to move relatively on a preferably frame-shaped, other component (3) by means of a guiding device (6) designed as a linear guide (119) and/or rotary and/or gear guide.

16. Displacement unit according to one or more of the preceding claims, characterised in that at least one component (3; 4) comprises one or more standardised interfaces (95) for control lines (49) and/or lines (50) of further assembly and/or processing devices and/or additional displacement units (1) and/or for power and/or of control units (7).

17. Displacement unit according to one or more of the preceding claims, characterised in that in the region of the interfaces (95, 101, 129) inputs (52) and/or outputs (54) of the control unit (7) are arranged, which are line-connected by plug connectors, in particular coupling devices with at least one control unit (7) of an additional displacement unit (1).

18. Displacement unit according to one or more of the preceding claims, characterised in that the switching modules (10) are arranged on the drive unit (5) or are integrated into the latter.

19. Displacement unit according to one or more of the preceding claims, characterised in that the switching modules (10) are designed as valve cartridges (115), which are arranged in a guiding device (103) of the drive unit (5).

20. Displacement unit according to one or more of the preceding claims, characterised in that the switching module (10), in particular the valve cartridge (115), comprises a control module (9).

21. Displacement unit according to one or more of the preceding claims, characterised in that the pneumatic drive (12) designed as a pneumatic cylinder (13) has end face closing elements (14), which are positioned so as to be adjustable relative to one another on or in a cylindrical pipe (15) of the pneumatic cylinder (13).

22. Displacement unit according to one or more of the preceding claims, characterised in that the signalling and/or monitoring members (16), are for example limit switches and/or proximity switches (17) and/or displacement measuring systems and/or position detecting systems and/or vibration sensors and/or force sensors.

23. Displacement unit according to one or more of the preceding claims, characterised in that the component (3; 4) is secured by a securing device (122) arranged detachably on the other component (4; 3) in at least one direction of movement.

24. Displacement unit according to one or more of the preceding claims, characterised in that the securing device (122) is formed for example by a damping device (123), a braking device or an arresting device.

25. Displacement unit according to one or more of the preceding claims, characterised in that the control unit (7) comprises at least one display element (75), which is designed for example as a display (76) with text, number display, light-emitting diodes or as an acoustic information element.

26. Displacement unit according to one or more of the preceding claims, characterised in that the control unit (7) comprises an input device (77), for example in the form of a keyboard (78) or a touch screen.

27. Displacement unit according to one or more of the preceding claims, characterised in that the touch screen combines the display element (75) with the input device (77).

28. Displacement unit according to one or more of the preceding claims, characterised in that the interfaces (95, 101, 129) and/or the inputs (52) and/or the outputs (54) are designed as plug-in coupling devices.

29. Displacement unit according to one or more of the preceding claims, characterised in that at least one component (3;4) comprises an electric distribution bus bar (72) and/or a pneumatic distribution bar (55).

30. Displacement unit according to one or more of the preceding claims, characterised in that the electric distribution bus bar (72) and/or the pneumatic distribution bar (55) comprises control lines (49) and/or lines (50) and/or channels (61), which are preferably integrated into the component (3;4).

31. Displacement unit according to one or more of the preceding claims, characterised in that the switching modules (10) are arranged on and/or in the pneumatic distribution bar (55), which are preferably plug connected by openings (63) to openings (60) arranged in the pneumatic distribution bar (55).

32. Displacement unit according to one or more of the preceding claims, characterised in that one component (3;4) comprises at least one securing device (118) for the signalling and/or monitoring members (16), preferably in the form of a guiding device (103).

33. Displacement unit according to one or more of the preceding claims, characterised in that the signalling and/or monitoring members (16) and/or the switching modules (10) and/or the control modules (9) are arranged displaceably on the electric distribution bus bars (72), in the form of a bus line (97) for example.

34. Displacement unit according to one or more of the preceding claims, characterised in that the signalling and/or monitoring members (16) comprise control modules (9) and/or logic elements (139).

35. Displacement unit according to one or more of the preceding claims, characterised in that the input and/or output device (79), is designed for example as a keyboard and/or as a

reading device for chip cards, magnetic cards, CDs, diskettes, tapes and/or as a data glove and/or a touch screen.

36. Displacement unit according to one or more of the preceding claims, characterised in that the data is transmitted from the control unit (7) to the control unit (134) and/or from the individual components of the control unit (7) to the latter wirelessly, for example optically by means of lasers or for example by means of infrared or ultrasound.

37. Displacement unit according to one or more of the preceding claims, characterised in that the position of the components (3;4) and/or the mounting parts (2) is detected by means of a local positioning system.

38. Displacement unit according to one or more of the preceding claims, characterised in that the data glove is connected preferably couplably via inputs (52) and/or outputs (54) to the control unit (7) and/or the control unit (134).

39. Method for operating a displacement unit and/or a system composed of several displacement units, in particular an assembly system in which reference values for the displacement unit, such as for example the displacement in x and y direction, speed, cycle time, feed force etc. are predefined in a control unit, in particular a control module of the displacement unit or central control unit, after which the actual values of the displacement unit or of actuators, in particular switching modules, are detected and changed to said reference values, characterised in that by means of a learning mode provided in the control unit and/or in the central control unit at least one actual value of the displacement unit is compared with at least one reference value, adjusted to the latter or defined as a reference value, which represents a target value optimised for example with respect to cycle time, wear, vibration etc., to which the actual values are adjusted.

40. Method according to claim 39, characterised in that for each displacement unit a learning mode is executed in which the actual value of a prespecified target value is determined, whereupon after completing the learning mode of the last displacement unit said actual values are compared and are selected as a target value.

41. Method according to claim 39 or 40, characterised in that the target value is formed for example from the value of the greatest clock time of a displacement unit or by the cycle time.

42. Method according to one or more of the preceding claims 39 to 41, characterised in that the learning mode is formed by fuzzy logic, neuronal networks or genetic algorithms in the control unit, in particular in the control module.

43. Method according to one or more of the preceding claims 39 to 42, characterised in that after the learning mode has been completed or during the latter a monitoring mode commences, which determines the interval between two consecutive activations of the learning mode, stores it and compares it with other such intervals and on reaching a reference interval value sends maintenance information to the central control unit or an external input and/or output device.

Abstract

The invention describes a displacement unit (1) for example for supply, manipulation, guiding or control systems of mounting parts (2), with components (3, 4) that can be adjusted relative to one another by means of a drive unit (5) and with at least one guiding device (6) for at least one of the components (3; 4) and a control unit (7). At least one member (8) of the control unit (7) used for processing logic information or bus information is integrated into the drive unit (5) and/or into at least one of the components (3; 4) and/or is mounted on one of the components (3; 4).

Use Fig. 1 for Abstract

1/10

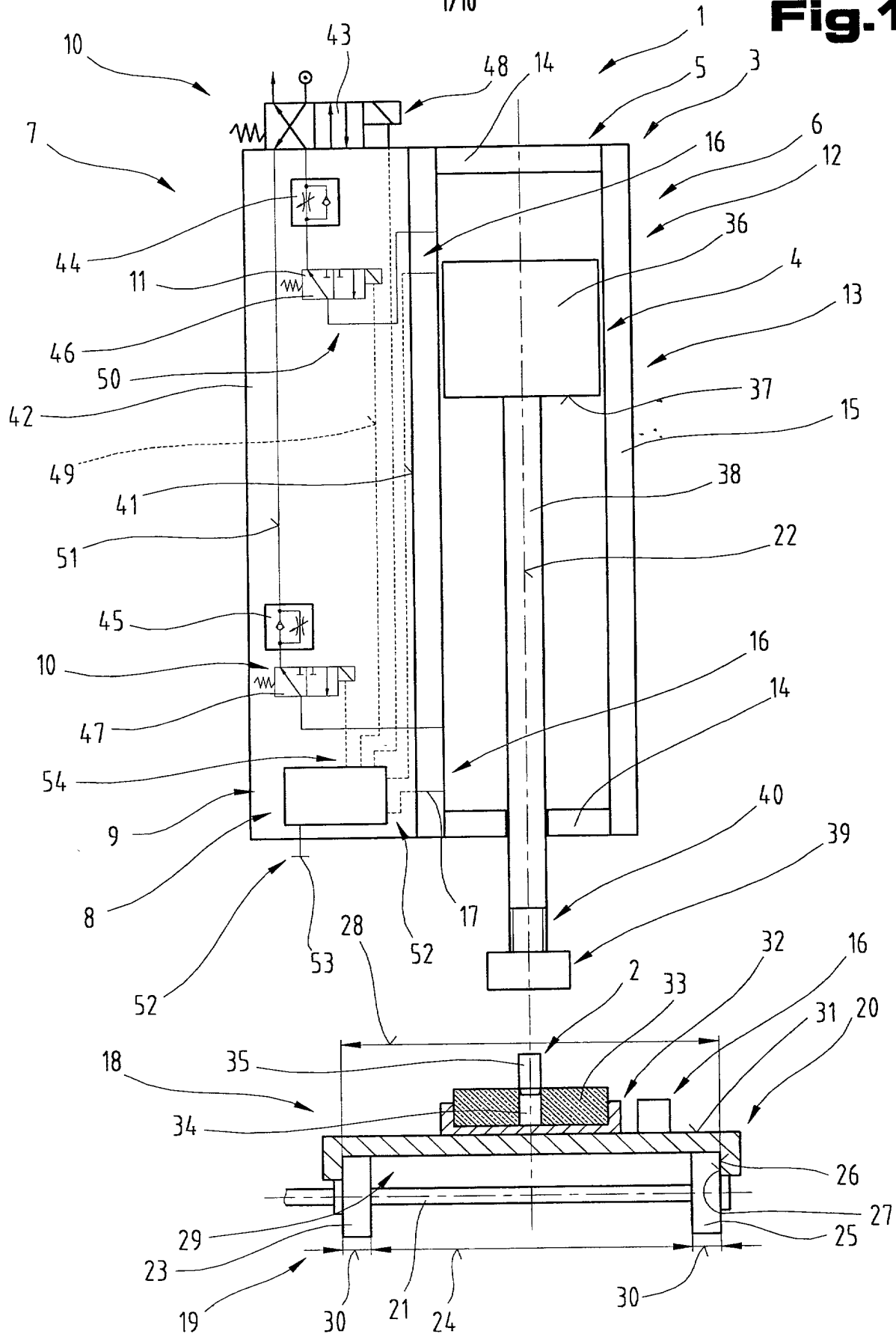
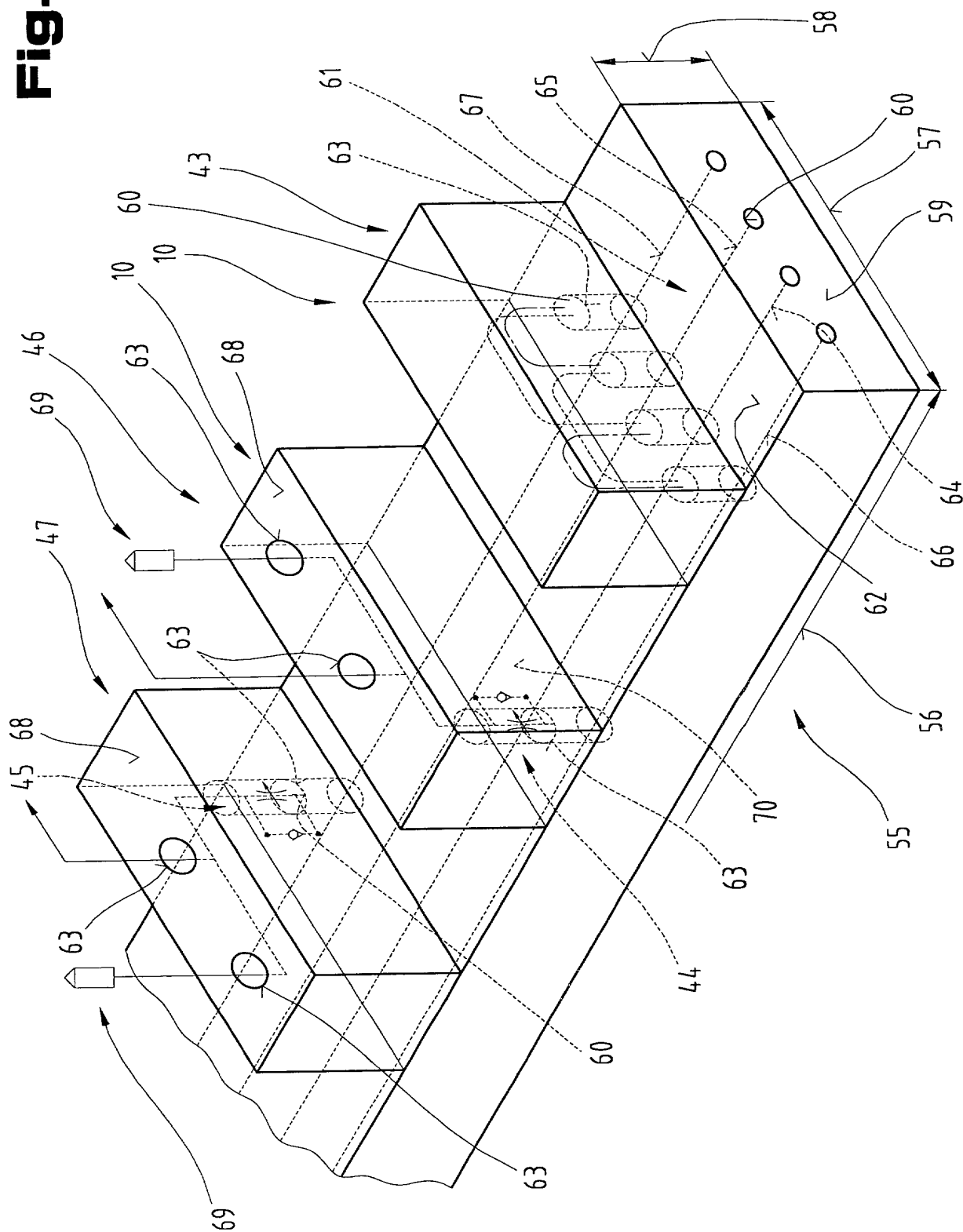
Fig.1

Fig. 2



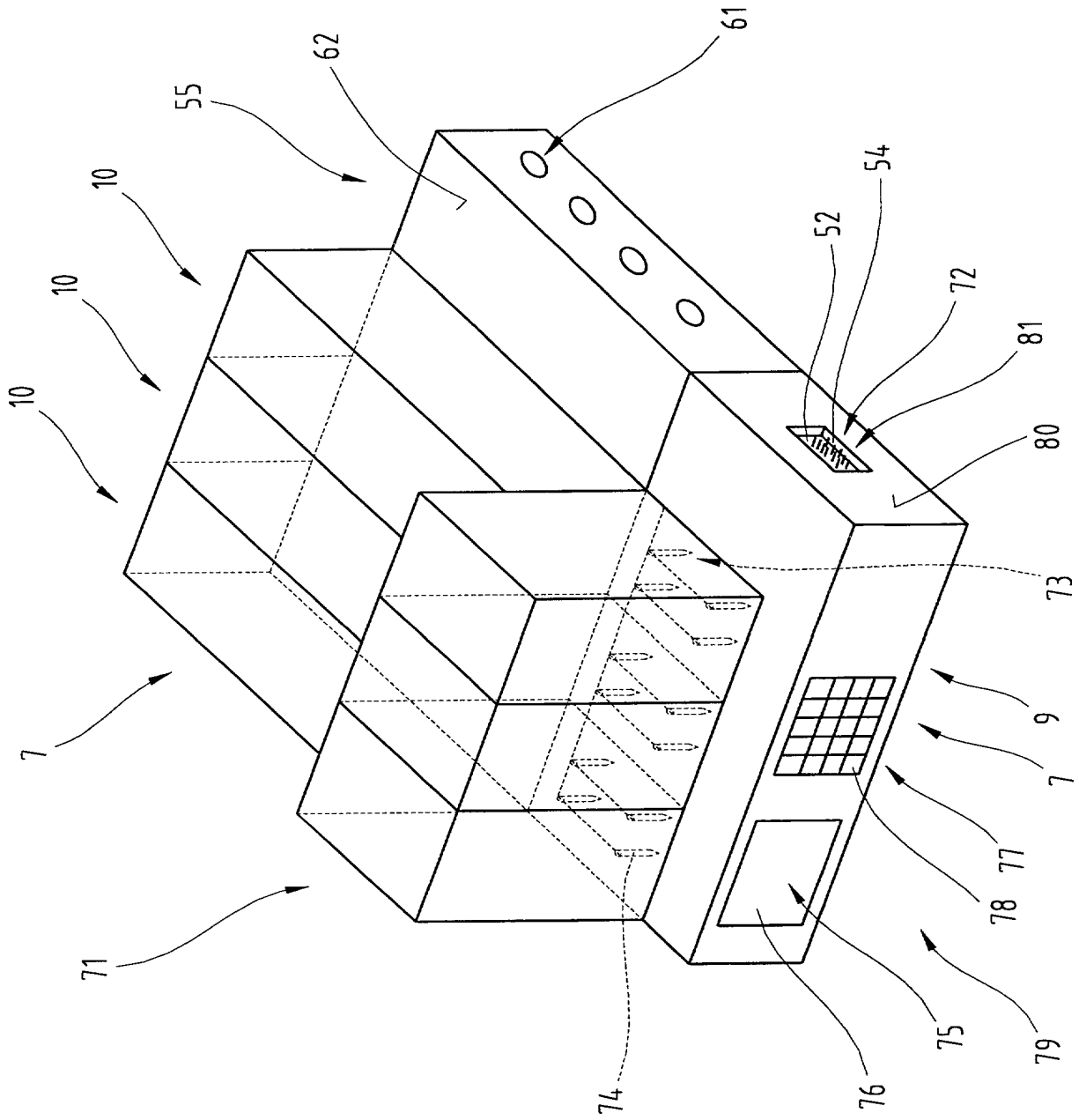


Fig. 3

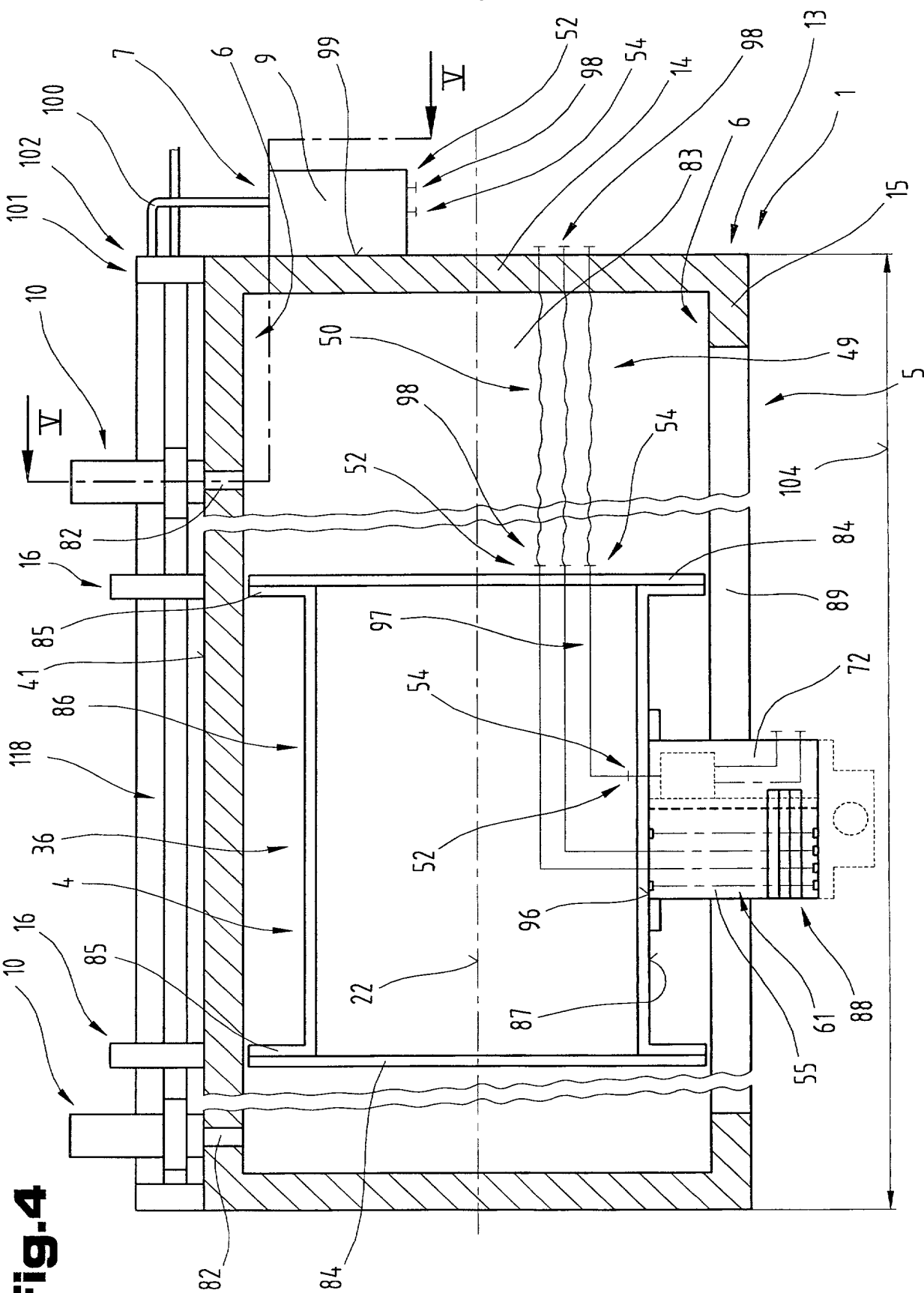


Fig.4

5/10

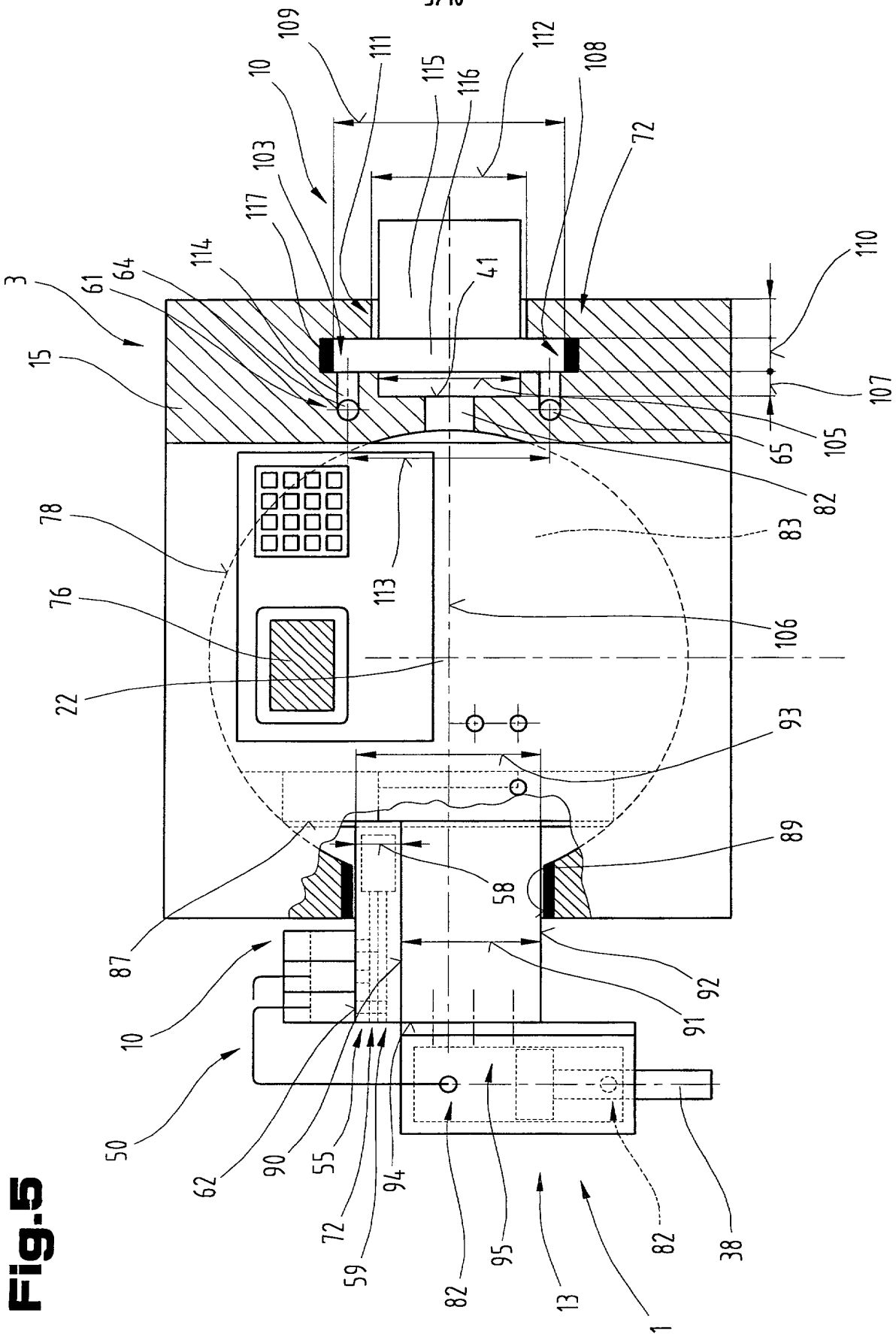
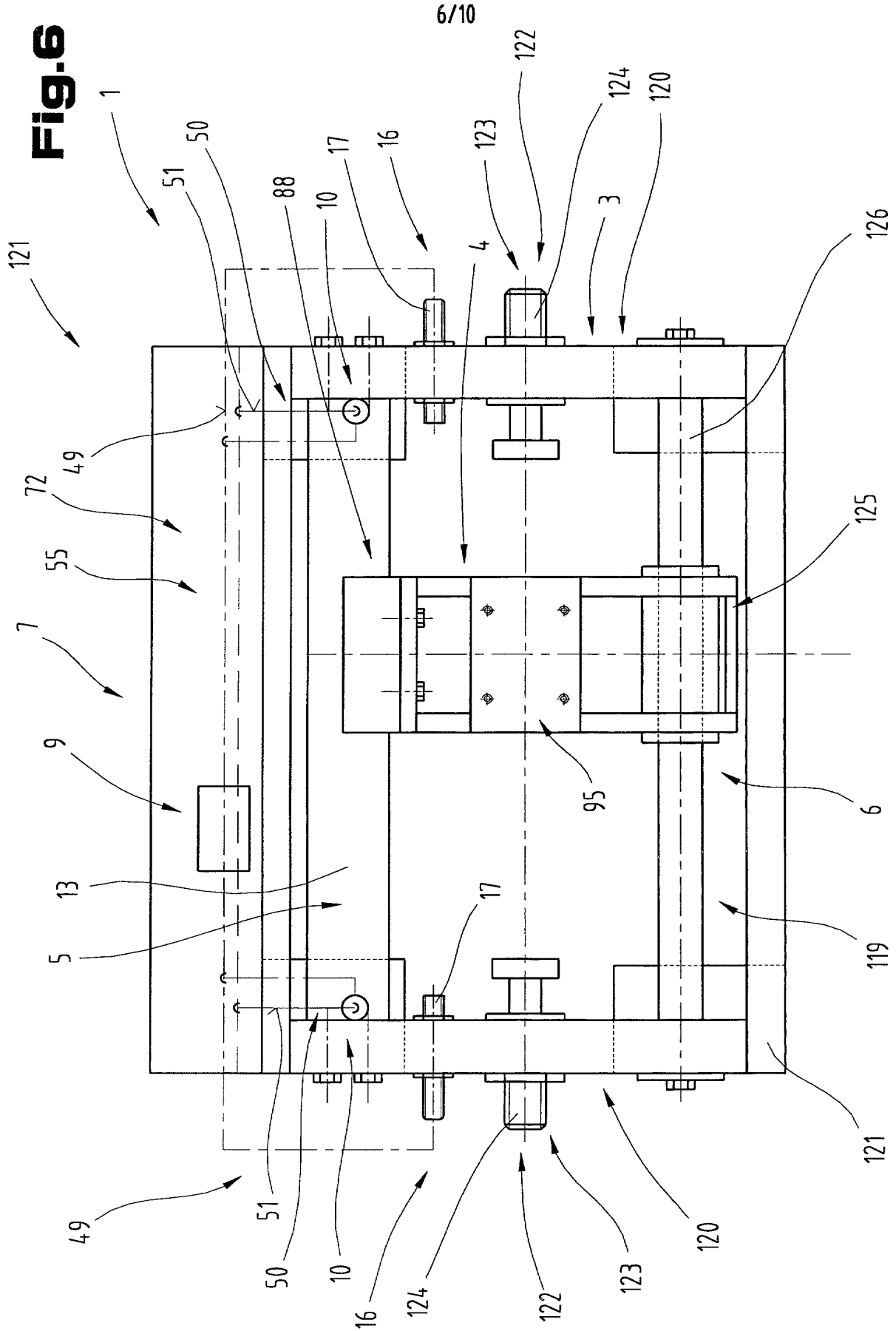


Fig. 5

Fig. 6



6/10

Fig. 7

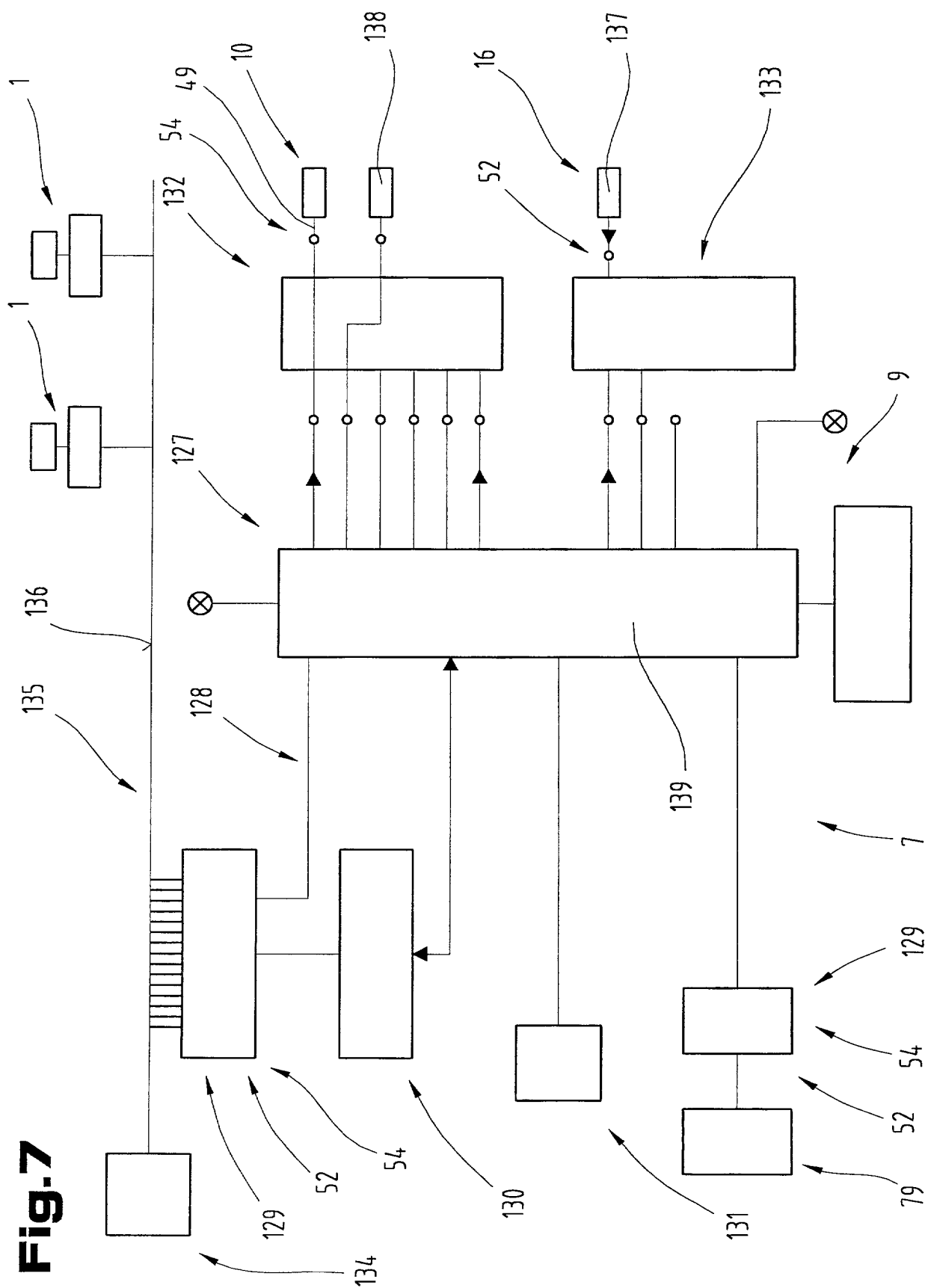


Fig.8

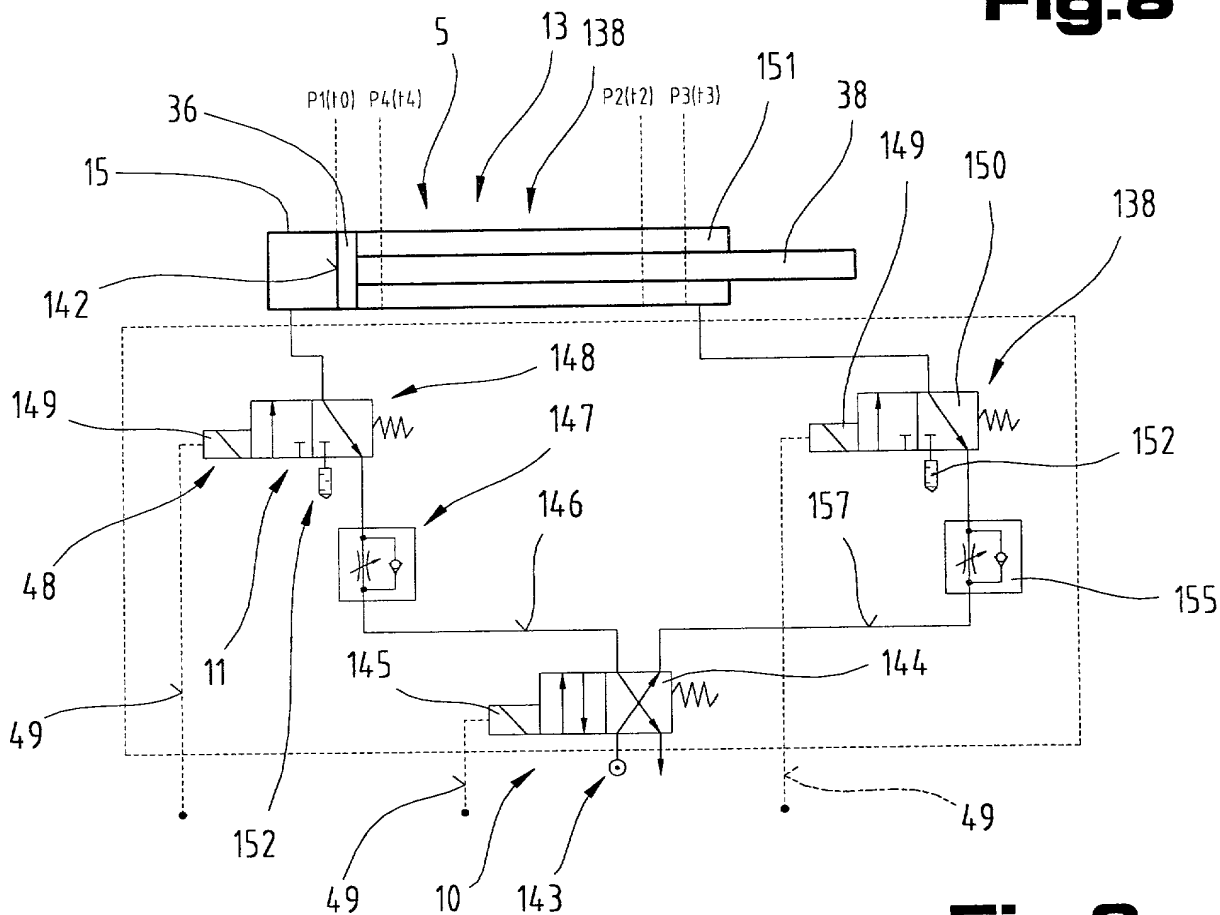


Fig.9

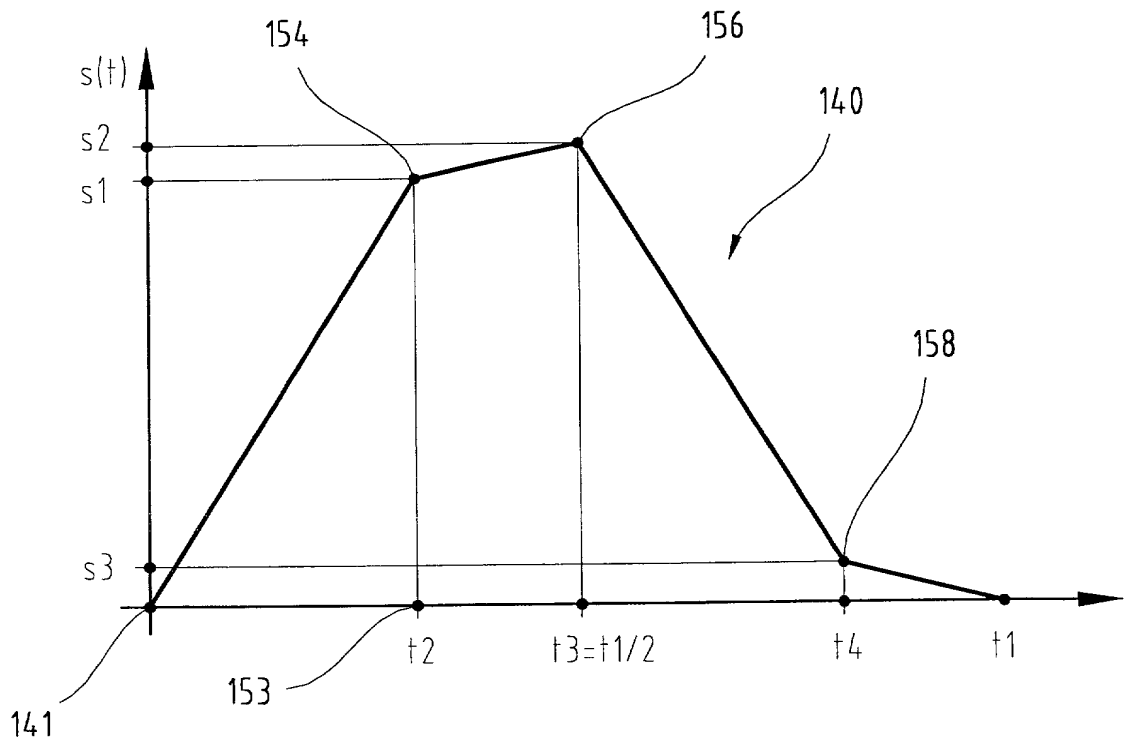
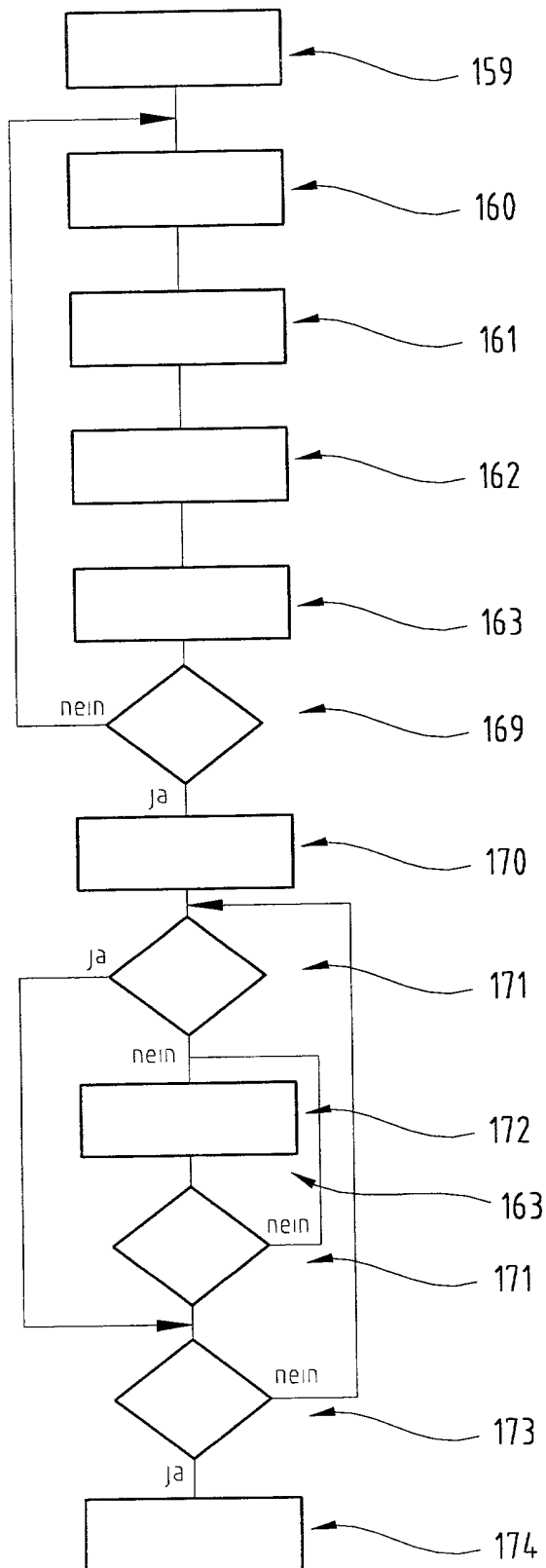
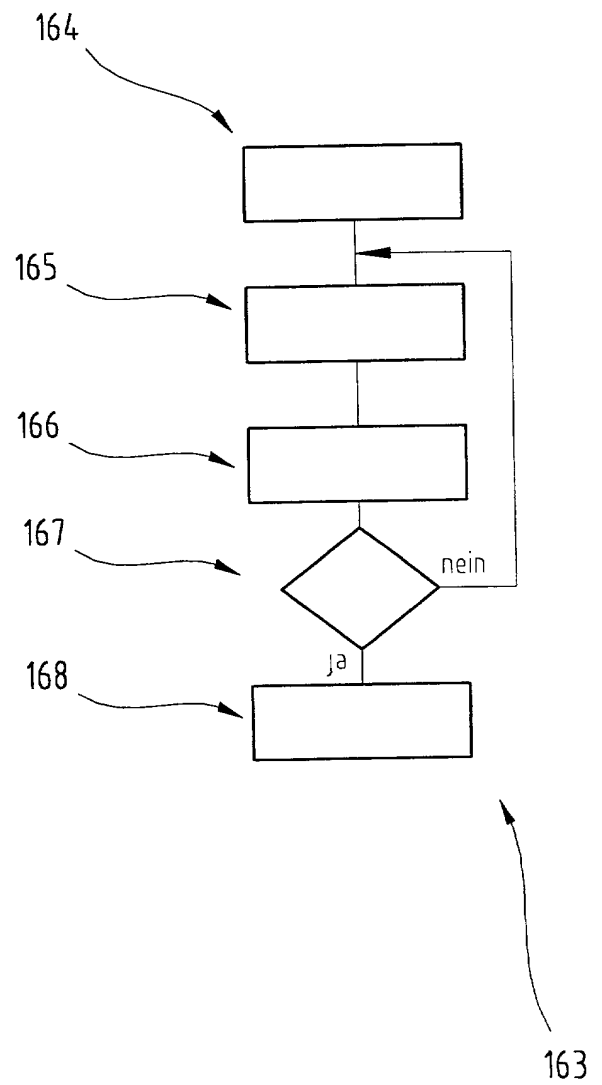
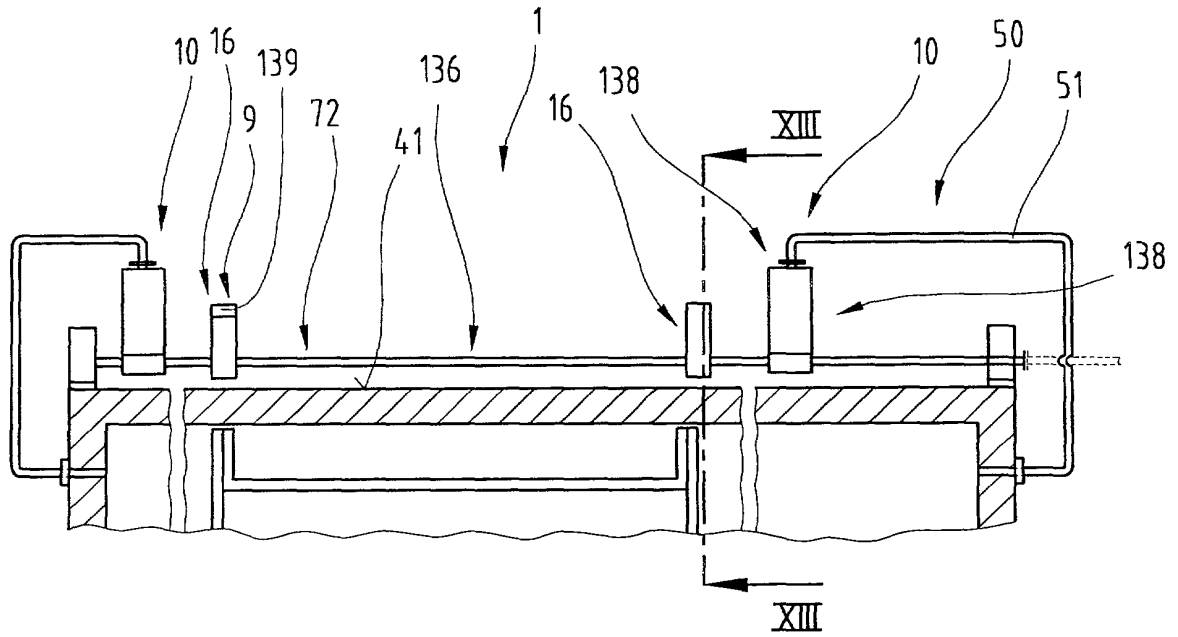
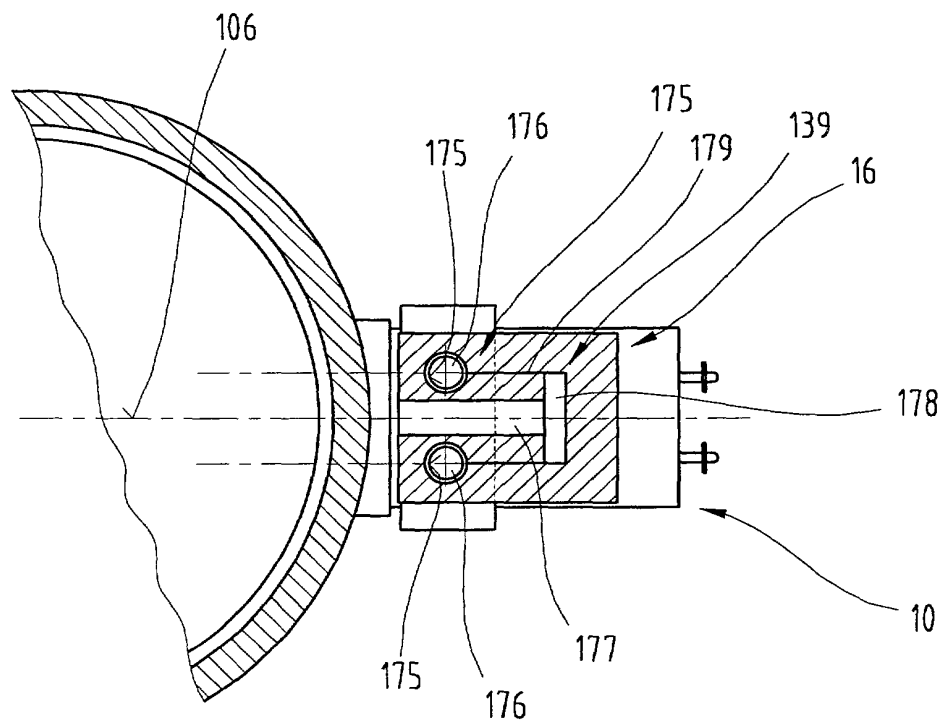


Fig.10**Fig.11**

10/10

Fig.12**Fig.13**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Smart axes and related method

the specification of which (check only one item below):

- ☐ is attached hereto.
- ☐ was filed as United States application
Serial No. _____
on _____
and was amended
on _____ (if applicable).
- ☒ was filed as PCT international application
Number PCT/AT 98/00194
on 18th August 1998
and was amended under PCT Article 19
on 11th October 1999 (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Austria	A 1384/97	18th August 1997	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS			STATUS (Check One)		
U.S. APPLICATION NUMBER	U.S. FILING DATE		PATENTED	PENDING	ABANDONED
PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO.	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (if any)			

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration numbers):

KURT KELMAN, Registration No. 18,628

ELIZABETH COLLARD RICHTER, Reg. No. 35,103

ALLISON C. COLLARD, Registration No. 22,532;

WILLIAM C. COLLARD, Registration No. 38,411

EDWARD R. FREEDMAN, Registration No. 26,048;

CHRISTOPHER B. GARVEY Registration No. 31,015

Send Correspondence to:

COLLARD & ROE, P.C.
1077 Northern Boulevard
Roslyn, New York 11576

Direct Telephone Calls to:
(name and telephone number)
(516) 365-9802

2	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	Sticht		Walter	
0	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
		Attnang-Puchheim ATX	Austria	Austria
1	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY
		Karl-Heinrich-Waggerl-Straße 8	A-4800 Attnang-Puchheim	Austria
2	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
0	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
2	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY
2	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
0	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
3	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201

SIGNATURE OF INVENTOR 202

SIGNATURE OF INVENTOR 203

DATE

15th March, 2000

DATE

DATE